OUTLINE OF GENERAL PSYCHOLOGY

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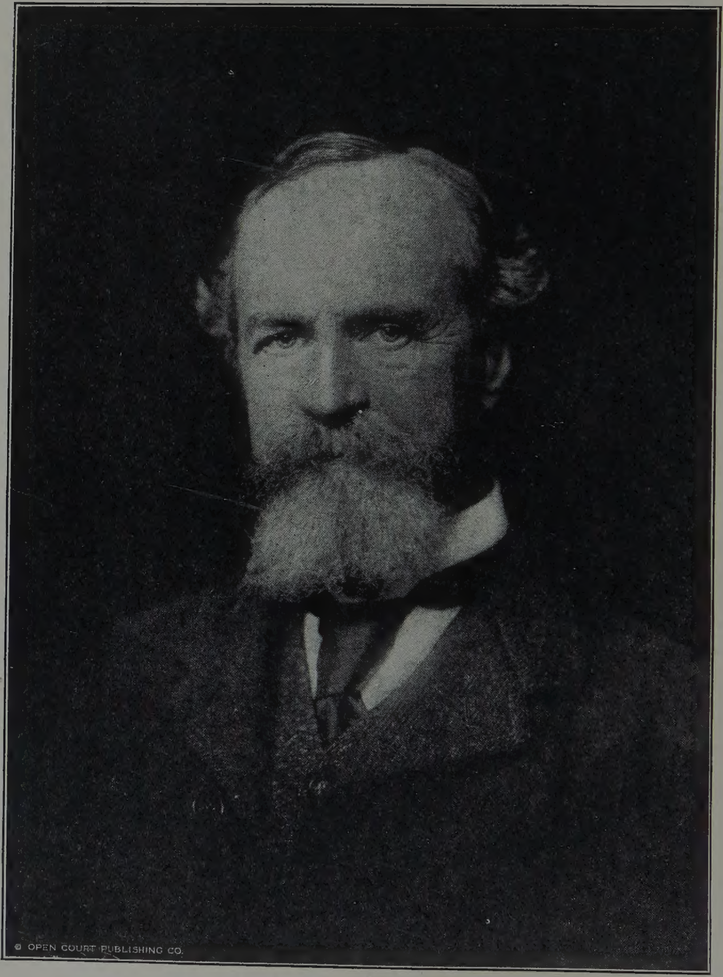
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WILLIAM JAMES

Frontispiece

OUTLINE OF
GENERAL PSYCHOLOGY

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NEW YORK · LONDON · TORONTO

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First Edition October 1925
Reprinted July 1926
Reprinted October 1927

MADE IN THE UNITED STATES OF AMERICA

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PREFACE

In preparing this volume we have hoped to be useful to two classes: to undergraduate students on the one hand, and on the other, to the body of intelligent readers outside of academic circles. There are many in the second group who want to know what psychology is about in our generation; what it has to say for itself. They are less interested in the methods that are peculiar to the science of psychology, than they are in the satisfactions it may provide for those to whom the behavior of men is one of the various languages of nature.

The professional psychologists of a quarter century hence must be recruited from amongst the students of today. If the recruits are to be sufficient in numbers and in zeal to accelerate the development of the science, their enthusiasm must be kindled while the courage of youth is in their veins. Of every science this is equally true. Tedious method and scrupulous care for details must come, but he whose students have acquired the momentum of enthusiasm need have no prickings of conscience because he has deliberately gone about it to do the stirring up.

We have tried in this book to avoid the appearance of adhesion to any *ism*. Ultimately every student of psychology is bound to become *behaviorist* or *functionalist* or *structuralist*, or what-not. He may, indeed, drift into one or another rank without awareness of whither he is tending until he shall have arrived. But this development need not be hastened in the beginner. For him we must select our data and present the material unbiased, so far as that is possible.

We have tried the experiment of introducing in this volume a chapter on the history of psychology. In this respect the book is an innovation amongst general texts. The material for this section must be drawn from the histories of physiology and neurology and philosophy; optics and acoustics and anthropology—and these are not all the sources from which strong influences have come to bear upon the science of psychology. Obviously, in view of the limitations of men's minds an adequate history of psychology is not easily compiled and we have found it difficult to condense the historical data into small space.

We acknowledge a heavy debt to authors and publishers who have generously permitted us to reproduce the following figures: Figures 3, 10, 21, 22, 29, from Woodworth's ''Psychology,'' published by Henry Holt and Company; Figures 5 and 7 from Hunter's ''General Psychology,'' University of Chicago Press; Figure 8 from Allport's ''Social Psychology,'' Houghton Mifflin Co.; Figure 13 from Foster's ''Experiments in Psychology,'' Henry Holt and Company; Figure 12 from the Psychological Review Company; Figure 17 from Warren's ''Elements of Human Psychology,'' Houghton Mifflin Co.; Figure 20 from Howell's ''Textbook of Physiology,'' W. B. Saunders Company.

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AN OUTLINE OF GENERAL PSYCHOLOGY

CHAPTER I

INTRODUCTION AND ORIENTATION

> "An intelligent person beginning to study *de novo* the broad facts which here concern us, unaided and unimpeded by traditional or current theories, would almost certainly not do what according to Tristram Shandy, Locke did, that is, write 'a history book of what passes in his own mind.' He would in all probability fail to distinguish sharply between the facts of mind and the facts of life which he observed on all sides: the close connection, that is to say, of living mind and living body would conceal their duality."
>
> JAMES WARD

What is the Subject Matter of Psychology?—The answer seems fairly obvious. Psychology is the science of *mind*—or, perhaps better, of *minds,* since there is no such phenomenon as mind-in-general. We might, by way of variation, define psychology as the science of soul, or of consciousness, or as the science of mental phenomena. Mind is perhaps the most convenient and the least ambiguous of many available terms. Psychology, then, is the science that investigates minds to discover *what they are,* what may be their nature, structure, mode of functioning—their relationships and potentialities. Pursuit of this knowledge is encouraged by the expectation that it will aid in the understanding and control of behavior.

But the goal is distant and our progress slow. Psychologists have long since given up the notion that there is a "royal road" leading straight away to the object of their inquiry. In truth, it is difficult even to establish a preliminary formulation of the science and its central problem. "Everybody," as Ward remarks, "can tell in a general way what psychology is about: in fact there is perhaps no science the subject-matter of which can be more clearly and promptly set forth in popular language and for practical purposes." But we must not fall into the mistake of supposing that psychology is a subject that can be grasped by an easy, off-hand effort, or that can be adequately presented in simple and popular language. Psychology is the most sophisticated of all sciences.

For the present, then, we have to consider how we may, to best advantage, go about our task. It is clear that we can never reach our objective—a knowledge of the nature of minds—by "arm chair meditation," or by dialectical reasoning from arbitrary premises, or by any other kind of performance except genuine first-hand study of the facts of mental life. Where shall we begin? With what facts? What methods? Students of psychology differ very seriously, sometimes, on questions of ways and means. In this country today our Structuralists, Behaviorists, Functionalists, and Self-Psychologists hold very different views as to the best methods of going about the business of studying minds. But, this shop talk need not trouble us at present. We are not compelled to take sides and are hardly in a position to do so, indeed, until we have made a general survey of the field, reviewed the elementary facts, and become acquainted with preliminary problems. One cannot plunge into psychology—headlong—and become a man of science without more ado. The scientific level of investigation, at least in psychology, lies high, and can be reached only by many preliminary steps. Let us begin at the beginning, then—so far as our preconceptions will permit—and follow the lead of the subject matter wherever it may take us.

The First Postulate.—When we begin to reflect upon the nature of the world about us, and to survey its multiform objects and changes, one of the first observations to be made is that there is a conspicuous difference in character between *organic* and *inorganic* beings. Aristotle, who had the naive eye of a beginner in science, distinguished these two classes of beings as the soul-less (ἄψυχα) and the besouled (ἔμψυχα). Living things are besouled; possessed of a "life principle." They grow, assimilate nourishment, reproduce themselves, follow recurrent cycles of development from seed to maturity and from maturity to seed. Sticks and stones do not do this: inorganic things are *inert,* as the physicists say. If we take *biology* as the science of life and living things, psychology will fall within its scope. Only living things have minds.

At the common-sense level of reflection we tend to think of minds as *things* possessed by living organisms. Certain creatures have, or contain, or embody minds. This is a rather ingenuous way of speaking, but it serves to give us orientation with respect to our central problem. In saying that organisms have minds we are not likely to mean that our bodies have minds attached to them, or conjoined to them, as if minds were little self-contained entities added to the organism as an accessory or after-thought. Our first meaning is, probably, that beings with minds are quite different in their *behavior* from things that are "soul-less." The word mind thus serves to indicate a unique trait or characteristic of certain organisms. Things with minds possess certain capacities in the way of behavior not found elsewhere in nature. This observation gives us our first postulate: our point of departure for the study of minds. **Things that have minds differ in their behavior traits from**

things that are "soul-less," and the interest of psychology is centered upon the explanation of this difference.

The Study of Behavior.—But explanation must, in scientific order, be preceded by analysis and description. Before we can make any progress towards the explanation of the differential traits of beings "endowed with minds" we must first of all investigate the type of behavior that we call "mental" and must secure a good empirical knowledge of its characteristics. In this preliminary discussion we must confine ourselves to the outstanding, primary facts about mental behavior. Among the animals, such as show indubitable signs of intelligence, this kind of behavior seems to be connected with the promotion of the well-being of the organism and its race. It has to do with defense, food-getting, and the propagation of the species. Let us not be led astray by the circumstance that different animals have different modes of behavior which accord with their structure and motor capacities. For among all of these creatures *mind* is exhibited in movements which serve for the maintenance of the individual and its species. Organisms develop, not merely as individuals, but as races, each species tending to achieve the fullest expansion that its environment permits. On the other hand, the environment, organic and inorganic, sets obstacles to such expansion. The creature, in order to prosper, must be able to adjust itself to the circumstances of its life. In the struggle for survival, against conflicting forces, the successful species will develop forms of behavior which will enable it to cope with danger or to utilize the natural energies which might otherwise be its destruction. Intelligent behavior is distinctly of this adaptive type.

These biological observations connect very easily with common-sense observations of everyday human life. How do we gauge intelligence in our fellows? By the efficiency of their behavior, as measured by the results to which it leads. A man has a good mind, we think, when he can promote his own interests, render service to others, or create works of art. On the other hand, an idiot cannot take care of himself, cannot help others, and can contribute nothing to the general interest. The human mind exhibits itself in behavior that leads to results advantageous to the individual and to humanity.

Some Kinds of Adaptive Behavior.—But while we have so far reached the conclusion that intelligent behavior is a form of activity connected with the maintenance, promotion, and general expansion of life, we have yet to observe that not all adaptive behavior is necessarily of the kind that we call intelligent, at least from a human point of view. This is an interesting point, that is more important than is generally supposed. A great many lower animals, especially those in whom *instinct* is strongly developed—such as the social bees and ants—are capable of a type of adaptive behavior which is quite unlike human conduct. These animals appear to act like little automata. They have a generous endowment of purely reflex modes of behavior. Their little bodies are tuned and set to act in certain determinate ways in the presence of certain stimuli—and they react with admirable efficiency. We of the human family, too, have a great stock of purely reflex activities. And our *habits,* too, are no more than acquired reflexes—or at least they have been so interpreted. The instinctive, automatic, reflex type of response of the lower creatures finds its nearest analogue with us in habit. With what precision do our habits unroll themselves in appropriate responses—when we let them run unchecked! But human habits are built up by the individual himself in the course of his own lifetime. The modes of behavior of the automatic creatures are *inherited:* they are *habits formed by the race.* These animals, it seems, have very little ability to learn. They come into the world with their habit-like ways of acting all set and waiting the touch of proper stimuli to put them to work. How helpless are these creatures when removed from the environment to which they are organically adjusted! How routine and almost fatally fixed the cycle of activities to which they are committed by inherited structure!

Much of human conduct (and, indeed that of many higher animals) is, by contrast, well-nigh unpredictable, so great are the modifications to which it is amenable. There is deliberate conduct. How does habit among us, compare with it? Habitual conduct is characteristically inattentive. We lace our shoes, button our coats, unlock doors—perform a thousand and one acts without giving thought to what we are about. These things somehow get themselves done. They require no attention. Here, then, is a significant difference. Habitual conduct is automatic: deliberate behavior is always accompanied by awareness of what we are about, by *attention to what we are doing*.

But what is the significance of attention in relation to behavior? **Men attend in order to anticipate. Conscious behavior lies in wait for the next event.** Observe a dog, for instance, when attending to an object. Plainly this behavior is *anticipatory;* watchful, careful, set to go this way or that, and ready to sense the first direction of change. The organism is prepared to act in any one of a number of ways, and these responses are all on hair-trigger, any one of them ready to explode into action. Men exhibit the same kind of anticipatory behavior in the face of a puzzling situation. This is the behavior that we call attentive. It is always directed to the future; set for what is coming.

Habitual—and other forms of inattentive response—are *not* anticipatory. They are directed exclusively to the here and now, set going and kept going by what is *here*—by direct stimulation of the organs of sense. Such behavior takes no account of what is *going* to be here. It is not prepared to do so.

The Biological Significance of Attentive Behavior.—We live in a world of change where things are undergoing constant transformations. The unexpected may happen. That, of course, is why it is an advantage to be able to adjust oneself promptly to whatever changes fortune may impose. A creature that is purely automatic, equipped with just a certain set of stereotyped responses—no matter how numerous they may be—is at the mercy of *novel* circumstances. Let it confront a situation for which nature has provided it no adequate responses, and it must perish. It is putty in the hands of fate. Nature, in the course of ages, has favored those organisms that are *plastic*—that are capable of learning to act in new ways under new conditions. It has furnished them, not with a fixed lot of response systems, inherited with the body, but with a brain and a nervous system susceptible of endless modification, which makes them highly adaptable. Such creatures contrast strongly with others that are merely adapted.

Behavior is "Organismic."—No analysis of behavior would be complete without reference to the fact that intelligent conduct is integrated, coordinated, harmonious. The intelligent individual *acts as one,* so that his movements are appropriate, each in its place; so that each distinguishable act within a complex or series is related to every other act. The individual behaves as one rather than as *many.* If each muscle or gland of the body tended to act independently of others, if the act of this moment were contradicted by the act of the next moment, if the organism attempted to run and to sit down in the same breath, this inner lack of harmony would be exhibited in a form of behavior which would indicate "loss of mind."

The activity of an intelligent man in any situation calling for prompt measures contrasts with that of a dolt most conspicuously in this respect: that the intelligent man goes "straight to the mark," and that his successive acts are such as further, each in turn, the total activity upon which he has launched himself. The inferior person is uncertain and vacillating, full of starts, stops, and meaningless movements; he finds it difficult—in a word—to "pull himself together" and to act with effective coordination of his powers. Centrality and balance of behavior depend upon some principle of integration that welds our activities into a single whole.

The nervous system of an animal, we shall presently see, has a unifying function. By means of nervous connections the various members of the body are linked into a single organism, each part contributing its special function to the coördinated whole, which, in turn sustains each part. This is no less true of the sensori-motor system, which controls external behavior, than of the autonomic system, which coördinates the internal processes of the body. The unity of our bodily being, in all of its processes and movements, is the indispensable condition of intelligent individuality.

Behavior is Teleological.—We may observe, next in order, that behavior is known to be effectively coördinated only when the observer is aware of the *end* towards which the activity is directed. Certain persons standing on a street corner in Chicago one evening saw a man pass by, walking madly, jaws set and arms aswing, every muscle on the stretch. In a few moments he passed again, having in the meantime, presumably gone around the block. "The man must be demented," was the comment. He passed again, and the conviction deepened that he was not "right." But presently he came to a stop before the group and one of them, more observant than the rest, inquired, "What time did you make it in?" The man's reply indicated that he was an athlete, taking exercise to keep in training for the walking races in the Olympic games, which were to be held a few months later. When these folks *knew* what the man was trying to do, it became clear to them that his activities were remarkably well coördinated; that he was a skillful athlete. Without knowledge of the man's object his behavior appeared to be extravagant and ineffectual.

We cannot understand the activities even of a machine, unless we know what it is designed to do. No question is more frequent, where mechanical contrivances are on exhibition, than—What is it for? We may watch the complicated activities of an apparatus in motion for an indefinite period, study them most minutely, but remain wholly unable to judge whether the apparatus is well designed or a bungling job, unless we somehow manage to learn what end it is supposed to accomplish. An analysis of the functioning of an organism and its parts requires—even more imperatively—a knowledge of the ends which its activities are supposed to promote. Intelligent behavior must be interpreted in terms of the category of means-and-ends. A great many scientists avoid "teleology" as they would the plague. There is considerable misunderstanding of the real meaning of the term. We must use it, however, with the meaning already indicated, to designate the fact that conscious behavior is unintelligible apart from purpose—from the organization of behavior with respect to ends to be reached.

Purpose, interest, choice, aim, design, plan—these are the very heart of intelligence, as it appears on the human plane. What would a mind be that *had* no interests, no preferences, no expectations? Intelligence clearly implies a capacity for anticipation, and the direction of activity in accordance with prevision.

The Conscious Processes.—Psychologists commonly speak of many "mental processes," and in the chapters that follow we shall treat of sensing, perceiving, remembering, feeling and willing as if these were so many separate activities. But, in truth, there is only one *conscious process*, which, like a versatile actor, plays many parts. When mind is directed to the apprehension of things present to sense, we call the activity *perceiving;* when it is directed towards past events or things absent, we call the activity *remembering;* or, when the mind is bent upon doing something, we call the process *willing.* It is convenient for us to consider the mind of man as comprising these processes and others in their relationships.

In this book we follow the order that has become conventional in modern psychology. We consider: 1. The cognitive processes by which we "know something"—attending, perceiving, reasoning, etc. 2. The feeling states in which we "feel somehow." 3. Will and action in which we behave somehow towards things.

Methods of Investigation in Psychology.—*Introspection.*—Many psychologists have confined themselves exclusively to "looking in" upon their own mental states (introspection) and describing what they discover. When you are a hundred miles away conjure up an image of the house in which you live when you are at home; examine it and describe it. That is introspection and report. You are the only person who can describe that image because you are the only one who has the experience. I have no awareness of your image whatever except as you tell me about it. This is sometimes called a subjective method. It has serious limitations but it has yielded valuable results at the hands of careful practitioners. Broadly speaking we cannot get on without it. You are introspecting when you report that the piece of iron in your hand is heavy.

Objective Method.—A lower animal can describe nothing by word of mouth. Whatever one learns of his psychology must be got by outside observation of him. The observer may draw whatever inferences the facts seem to warrant as to his subjective (thinking, feeling, etc.) aspects. Very young children and adults too, in many circumstances, are in this respect, in the same class with the lower animals. In fact many psychologists keep as far away as possible from the inevitable imaginings and failures of memory that interfere with reporting after introspection and tie themselves in the fullest possible extent to the "objective" method.

Experimental Method.—Psychologists tolerate no haphazard introspection and no fortuitous objective observation. Experimental methods are available as aids to either form of observation. The "subject" is placed in a controlled situation and is asked to observe a certain experience introspectively and to report. Or again he is placed in a controlled situation in order that an observer may look at him and describe his behavior. In either case the experiment can be repeated over and over at any time and place. Results can be compared. It is thus that one of the prime requirements of an experiment is met. An experiment must be so staged that it can be described and repeated.

Experimental investigation represents by far the most important phase of present-day activity in psychology, both in relation to the subjective and the objective approach. But it was in connection with the introspective or subjective approach as an aid to it that experiment in psychology was first developed; chiefly under the impulse given by Professor Wundt.

Statistical Methods.—When the controlled conditions of the laboratory which characterize experiment at its best are not available, we proceed with such other means of control as lie within our power. A great number of studies have been carried on, in modern times, by questionnaire methods, which collect vast masses of information on special problems. Such, for instance, was Galton's method of studying the human imagination. The methods of differential psychology, which employs tests and measures of human performances, are similar in character. Such methods, which may, in a general way, be called statistical, must be employed with the utmost caution. But when used intelligently, and with a full realization of the limitations which statistical means involve, they may lead to results of very great value.

Divisions of Modern Psychology.—Mental phenomena, we have said, are exhibited under many different conditions and circumstances. Hence we have various divisions of the field of psychology.

Besides the study of adult human consciousness, which is the keystone of psychological science, it is possible to make a study of **social** psychology. Here we study the human mind as it exhibits itself in social intercourse. The main object is to discover the conditions that facilitate the development of social unity and the capacity for coöperation and at the same time to find the opposing conditions. It seeks also a way whereby the facilitating conditions may be made effective. This field of inquiry has been considerably developed in recent times, with interesting results. *Racial* psychology, an inquiry into the mental peculiarities of various races, is an extension of social psychology.

Under the head of **genetic** psychology we find several branches of investigation. **Animal** psychology and **comparative** psychology are closely related, the former treating of the intelligence of the lower animals, and the latter comparing with one another and with human faculties, the different forms of intelligence thus discovered. Animal psychology has been largely advanced in the last three decades through the introduction of experimental methods. **Child** psychology also belongs under this head, as treating of the nature and the growth of the immature mind. **Folk** psychology, although not widely pursued in these days, at least in psychological circles, treats of the development of intelligence in the human race as a whole, as such development may be traced through the customs and institutions which men have established.

Abnormal or medical psychology deals with mental pathology. This is a very fascinating and extensive field of study which has been developed by a host of workers. It must be acknowledged that no special branch of psychology in recent times has contributed more to our understanding of the nature of minds than the study of mental and nervous diseases. Here we find the normal unity and coherence of the mind breaking down under the stress of structural or functional disorders. It is inevitable that the study of the phenomena of dissociation, of the ways in which the mind falls to pieces, should throw great light upon the structure and function of the normal human mind. But, of course, we must not measure abnormal psychology merely by its contributions to our understanding of normal phenomena; it has a distinct field and mission of its own.

Differential psychology, a distinctly American development, undertakes to study individual differences—the significant ways in which individuals differ from one another. Its aim is definitely practical. It is a continuation, on a new level, of the enterprise formerly represented by phrenology. It might very appropriately be called—as has been suggested—*characterology.* It is in this field that "mental tests," with which the public has been made familiar, were first developed. But other devices of analysis and measurement are employed as well. Differential psychology is of immediate importance in the educational and industrial fields, where it has been successfully employed. It is now occupying a great deal of attention in this country, and promises profitable developments.

But there are other forms of *applied* psychology: for instance, the *psychology of advertising,* and the *psychology of salesmanship* and *public speaking.* These represent an application of the principles of general psychology to human activities. These forms of applied psychology may, as in the case of psychology applied to advertising, develop inductive and experimental programs which contribute new data to the general science.

General Psychology.—In this book we are not directly concerned with any of the special branches of psychology. The office of *general* psychology, as distinct from special forms of inquiry, is central and coördinating. Our object, we have said, is to determine, so far as may be, the nature of minds. That objective we hold steadily before us, and in its pursuit we call to our aid information from all available sources. The field of general psychology is not limited by arbitrary barriers. While its point of departure is adult human psychology, it may very well discover in abnormal, genetic, or differential psychology data of the greatest significance for its purposes. Indeed, the general psychologist may leave the field of psychology proper and step into biology, or ethnology, or philosophy, as occasion seems to demand. For, after all, the barriers between our fields of study are artificial. They are matters of expediency. The scientist who hotly pursues his quest will disregard them whenever occasion arises: this has been demonstrated by many a great thinker. It is not otherwise with psychology and the pursuit of general psychology.

This book purports to be an outline of general psychology. Because of its central position general psychology constitutes a natural introduction to the whole field. From it all special forms of inquiry take their origin; by it the results of psychological inquiry are brought together, synthesized and interpreted in the light of the central problem of our science. Psychology begins in general psychology: ideally, it should ultimately end in it.

Psychology in Relation to Other Sciences.—So much for a preliminary sketch of the inquiry to which psychology is devoted. It is well that we should remind ourselves, before we have gone too far, that psychology is *not* the only science of human nature. Man is a microcosm: a universe in miniature. There is no science which does not, directly or indirectly, contribute something to our knowledge of man. For man is physical, and subject to the laws of matter and motion; he is chemical, and his chemical processes have been intensely studied; he is an animal organism, and as such subject to biological interpretations. The physical, evolutionary, historical, and social sciences all contribute their quota of information to our knowledge of human nature in its many aspects and showings.

Psychology, indeed, is not the exclusive science of mind: for there is **logic,** an old and well-established discipline, whose contributions to our subject cannot be slighted. And psychology is related not only to logic, but to several other philosophical disciplines as well, for its formulation and for its basic terminology. Psychology used to be taught exclusively by philosophers. It is the latest of the disciplines to leave "the mother of the sciences" and set up house-keeping for itself. It is not surprising, then, that the ties between philosophy and psychology remain for many students close and mutual.

If, then, we are to regard psychology as an independent science—no science is independent, of course, in more than a relative sense—we are at the same time to recognize that it is compelled to fall back upon other sciences for a great deal of knowledge concerning human nature which is indispensable to its own progress. The student who would conduct research in this field must have an intelligent understanding of the outlines of several of the principal sciences. Thus, if he would undertake a study of vision, he must have at least enough knowledge of optics to know where to go for assistance in his experimental undertakings; or, if he would study emotion, he must have more than a superficial knowledge of physiology.

The sciences, as has often been observed, form a kind of hierarchy, in which mathematics and physics are basic, the others developing in turn. Psychology, a comparatively recent science, presupposes the older sciences and, in a manner, rests upon them as a foundation. Let us especially note some of the closer ties between psychology and other sciences.

Psychology and Physiology.—The relationship between psychology and physiology is one of mutual dependence. The physiologist who studies the functioning of the human body is compelled, as he advances, to take account of the facts of the mental life; the psychologist, on the other hand, cannot get very far without some knowledge of physiology. Everybody knows that a disease or injury of the brain is likely to affect the mental processes. The relationship between the mind and the brain is so close, indeed, that psychiatrists are very often able to determine, by the form of mental perturbation exhibited, the exact nature of the injury to the brain that is involved.

There is a special branch of our science, **physiological psychology,** devoted to a study of the correspondence between our bodily and mental processes. Nay, even further, certain psychologists declare that this is the only valid form of the science; that we can make no progress in the interpretation of mental phenomena except by referring them to physiological causes and conditions. We are not prepared, at present, to estimate the value of this opinion. It may be observed, however, that in actual practice physiology lags behind psychology. We know more about the mental processes of association and volition, for example, than we do about the brain processes which attend them. Physiology must here take its cues from introspective psychology. It is likely, then, that for many decades to come the psychologist will be compelled to pursue his inquiries—at least in the field of the higher thought processes—without decisive assistance from physiology.

We may note also that the science of physiology, as at present conducted, is devoted to the study of the body *as* a body with only incidental reference to purely mental functions. Physiological interpretations are physical and chemical. We might say—in a broad way of speaking—that physiology seeks to ascertain the respects in which organic beings are *like* inorganic things: the prevalent categories of the science are mechanistic. Whether these tendencies are good or bad the physiologists must determine. But psychology, we learned, is by its "first postulate" devoted to the study of the *differences* in function and behavior between bodies which are "besouled" and those which are "soul-less." Now this distinction in attitude and approach must continue, for some time to come, to separate psychology and physiology as independent undertakings. Nevertheless there is a strong community of interest between them, and perhaps in the long run we shall find them merging into a single science. Man is, after all, a concrete whole embracing many distinguishable parts and aspects, and our theory impels us to suppose that physiology and psychology are studies of one and the same reality from different angles of approach. The reader will find in this book many references to the physiological processes which support the mental life. This information is indispensable to an understanding of the work of psychology as a science.

Psychology and Logic.—If physiology is the science most closely related to psychology, logic is its nearest relative among the philosophical disciplines. Nobody is likely to suggest that the relationship between psychology and logic is as vital as that between psychology and physiology, but logic has, at all times, contributed greatly to our understanding of the higher thought processes. Some acquaintance with logic is, therefore, indispensable to the thoroughgoing student of psychological problems.

It should be observed that in speaking of logic we do not limit our reference to "formal logic" of the traditional type. Logic has developed in several directions in recent times, and has become a descriptive as well as a normative science. Professor Lodge's textbook of *Modern Logic,* for instance, is much more closely related to psychology than is the formal logic generally taught in our colleges. The wise student of the subject will avail himself of all the help that may be forthcoming from this direction. In the meantime our psychological texts will continue to carry, especially in their chapters treating of Conception and Reasoning, a great deal of material borrowed directly from this sister science of the mind.

CHAPTER II

THE EVOLUTION OF MIND

"Hence the dear name of mother, o'er and o'er
Earth claims most justly, since the race of man
Long bore she of herself, each brutal tribe
Wild-wandering o'er the mountains, and the birds
Gay-winged, that cleave, diverse, the liquid air."
—LUCRETIUS

Modern evolutionary theories have exercised great influence upon recent psychological thought, as upon all of the biological sciences. It is inconceivable that we should attempt to formulate the principles of general psychology, in this day and age, without reference to the work of Darwin and Spencer, and the great host of their followers in the genetic branches of our subject. In a general way evolutionary conceptions will temper our reflections throughout the course of this book. But we desire in the present chapter to consider the evolution of mind with the special object, justified in our introduction, of gaining thereby a preliminary conception and definition of the nature of the mental processes.

Genetic psychology has the one especial merit of giving us orientation in our subject. It takes us back to the most simple and primitive types of intelligence, revealing mind, one might say, in its fundamental and essential form. That is the one best reason why the definition of mind in objective terms is indispensable. There are, to be sure, many difficulties connected with genetic inquiry and particularly there are many circumstances which tempt the student into indiscreet generalizations. We shall be secure, however, if we remember the exclusively "objective" character of biological inquiry, and recognize that a purely objective method must be of necessity abstract and incomplete in the psychological sphere.

Before we go further it will be well to ask, with James, What are the criteria of intelligence? How do we decide in a given case, whether or not a being has psychical functions? "Only in organisms," says Professor J. A. Thompson, "is there true behavior—in which the creature is an agent and exhibits a correlated or concatenated series of acts, effective towards some definite result, favorable to the continuance and harmony of vital processes." An organism reacts to its environment in such a way as to preserve its unity and individuality, as if it had the purpose to maintain its life and further its own ends. Such reaction is, basically, intelligent, and a being capable of such response is said to possess intelligence.

It is a question whether plants ever can be called, in this sense, intelligent organisms. They do, as Aristotle pointed out, carry on the vegetative processes (which occur also in animals)—nutrition, circulation, metabolism, reproduction—and they seem in their life cycles to follow an immanent and characteristic plan of development. But plants, of course, have no power of locomotion. And lacking the power of locomotion and its accessories they are unable to make the "organismic" response: responses of the body "as a whole" which are characteristic of the behavior we call intelligent. The terms stimulus and response, indeed, have little meaning in reference to plant life. We shall confine our attention, then, to the intelligent responses of animal organisms. And in animals, at least, intelligent behavior is something over and above, superior to, the mere chemical and physical activities of the organism, in so far as these are local and partial. Intelligent response is primarily a response to outer conditions. It is, in other words, a form of interaction between the organism (as a whole) and the objects of its environment. Mind is often said to be a something that "intervenes" between sensation and reaction, between stimulus and response.

Intelligent activity, we have suggested, is characterized by *direction toward an end.* It is not blind response, but response aimed at the fulfillment of some purpose. "**The pursuance of future ends and the choice of means for their attainment are thus the mark and criterion of the presence of mentality** in a phenomenon," says William James. "We all use this test to discriminate between an intelligent and a mechanical performance. We impute no mentality to sticks and stones, because they never seem to move for *the sake of* anything, but always when pushed, and then indifferently and with no sign of choice. So we unhesitatingly call them senseless." Inorganic matter is inert; but organisms are able to *respond preferentially.*

The Protozoa.—Within recent times the behavior of a number of the protozoa—amoeba, paramecia, stentor, and others—has been observed from a psychological point of view. The results are interesting and worth noting. Consider the amoeba. The amoeba is a one-celled organism, scarcely more than a drop of protoplasm (a chemically unstable compound which has never been completely analyzed). It has the characteristic features of a cell; an outer membrane, a nucleus, and certain lesser structures of indefinite form and unknown function. The tiny animal carries on regularly the processes of nutrition, excretion, circulation, and reproduction. But, over and above these processes we find a certain capacity for locomotion, and *sensitivity.* The organism is capable of responding, *as* an organism, to stimuli which it somehow senses. The wonder is how it manages to carry on these activities without special sense organs and without a nervous system.

The behavior of amoeba is observable chiefly in its food-hunting and hurt-avoiding activities. If the animalcule encounters a harmful stimulus it withdraws the stimulated part. If the stimulus is sufficiently intense it sends out a "pseudopod" in an opposite direction and withdraws bodily from the injurious contact. If it encounters further stimulation of menacing character as the result of this bodily movement, it recoils in another direction. It acts as if it *intended* to escape the hurtful stimulus. Beneficial stimuli, in the main, cause no responses, but harmful stimuli will produce a vigorous and sustained effort to escape. The amoeba seems at times, also, to become hungry. It shows restlessness, becomes active, and moves about as if searching for food. When it finds a food particle it wraps itself about it and ingests it through its membrane by a process of osmosis. Summing up his impressions, Professor Jennings says: "The writer is thoroughly convinced, after

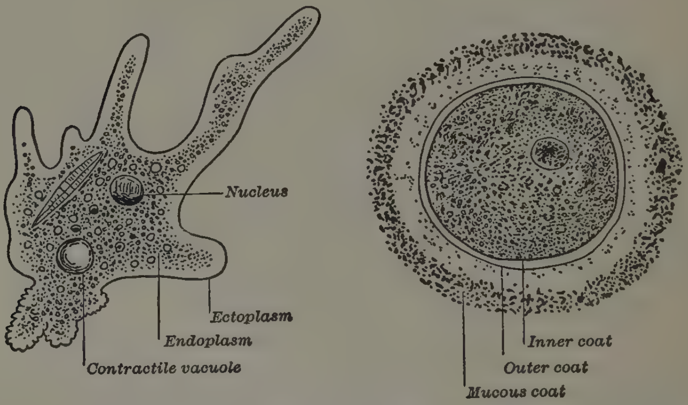

FIG. 1.—*Amoeba proteus,* free and encysted. In the former the movement is upwards and to the right. The pseudopodia are being produced anteriorly and withdrawn posteriorly. A diatom has been taken in as food, and food and other vacuoles are present in the endoplasm.

long study of the behavior of this organism, that if amoeba were a large animal, so as to come within the every-day experience of human beings, its behavior would at once call forth the attribution to it of states of pleasure and pain, of hunger, desire, and the like, on precisely the same basis as we attribute these things to the dog.'' Amoeba, in short, seems to be capable of a form of behavior that meets our preliminary definition of intelligent conduct.

The ciliated Infusorian, Paramecium, has also been studied with some care. This little slipper-shaped creature, barely visible to the naked eye as a whitish particle, is only a step more advanced in structure than amoeba. It is a mass of protoplasm inclosed in a fairly tough cortical layer from which projects hair-like cilia in oblique rows. The animal propels itself backwards or forwards through the water by movements of its cilia. ''One of these infusoria,'' says E. M. Smith, ''in coming into contact with *debris* or other objects stops suddenly, reverses the strokes of its cilia, thus causing a back-movement, then pausing, turns aside, and once more starts on a forward course, thereby completing the sequence of movements known as the 'motor reflex' or 'avoiding reaction.' If stimulated again by contact with another object, it repeats its maneuver, until it succeeds in passing the obstacle, or becomes fatigued.'' The animal seems to get ahead by a kind of ''trial and error'' process. On the whole it rejects or avoids what is injurious and accepts or seeks what is beneficial. Its conduct is, in appearance, purposive.

Stentor, another of the protozoa, is interesting as showing a rudimentary capacity to learn. This trumpet-shaped animal is found in marshy pools. It attaches itself by its narrow end to a weed, surrounding the lower half of its body with a mucous-like sheath, the so-called tube. Its ''mouth'' or open end is ciliated, the cilia serving to cause the water to flow into the open trumpet. Jennings experimented with Stentor by introducing carmine particles into the currents of water passing to the mouth of the animal. Its first reaction to such stimulation is to bend to one side, with a twisting motion. If it does not escape the carmine particles in this way it reverses the action of its cilia and tries to drive the water away from its mouth. If this response does not suffice Stentor withdraws into its tube. From this it emerges from time to time, remaining in its tube a bit longer after each contraction. Finally, if the hurtful stimulus persists, Stentor loosens its hold on the tube and swims away. Of this reaction Jennings says: "The same individual does not always behave in the same way under the same external conditions, but the behavior depends upon the physiological condition of the animal. The reaction to any given stimulus is modified by the past experience of the animal, and the modifications are regulated, not haphazard, in character." These protozoa, then, show a limited but definite capacity for intelligent response and adaptation. What the nature of this action may be, or what internal conditions regu-

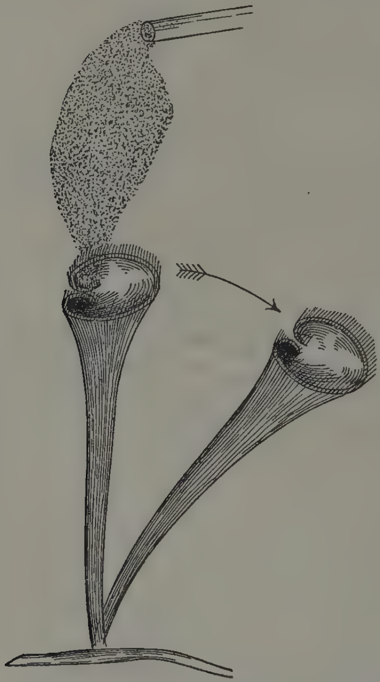

FIG. 2.—Stentor stimulated by carmine particles. (From Jennings.)

late it, we can only guess. But it is an interesting fact that evidences of intelligence are found in the lowest forms of animal life.

Sensori-motor Response.—As we leave the Protozoa and pass upward through the more complex forms of life, we discover several distinctive tendencies marking the progress of organic evolution. First of all, we find an increasing structural differentiation. From Protozoa, one-celled, to man, myriad-celled, lies a long stretch of evolutionary development, and the process is everywhere characterized by increasing complexity of structure. But differentiation means, also, *specialization*. The host of cells of the human body are all, indeed, cells specialized for particular functions within the organism. The cells which make up muscles, bones, blood, or nervous system are specially adapted to the work they have to do. Again, differentiation and specialization imply *organization*. The innumerable members of the organic whole act for one another and for the good of the whole which they constitute. An organism *is* an organism in the sense that "the cause of the existence of every part of a living organism is contained in the whole." Every part of an organism is what it is because of its membership in the whole and functions as it does because of the way other members function. If, then, in the course of organic development, we find increasing multiplicity and specialization, we find at the same time increasing unity or centrality. It is well, in any discussion of organic development, to emphasize this *nisus* towards *individuality*. Mere increase in complexity, taken by itself, is no proof of organic progress: it may mean death and disaster. But when the increasing complexity makes for greater organic freedom by contributing some new vital function which benefits the whole, we have a true evolution.

The first direction of this process is toward the development of sensori-motor systems. That is, of specialized sense organs, nervous connections, and organs of reaction. Amoeba is sensitive, we may suppose, in an undifferentiated fashion. Every point on its body is sensitive, but all points are sensitive, apparently, in the same way. In the higher animals this original sensitivity becomes specialized into sensitivity to gravity, light, sound, smell, heat and cold. Special cells take over, for instance, the business of detecting light stimuli, and in the course of time the photosensitive cells build around them special structures, known as sense organs, of gradually increasing complexity and efficiency. This increase in capacity for sensations paves the way for more effective response, and, parallel with the development of the animal's sensitive powers we find increased powers of response to objects in the form of motor structures. The "pseudo-pod" of Amoeba gives way to the segmented crawl of the worm, and this in turn to the development of fins, legs, and wings, of structures for attack and defense, and for dealing with objects. But the *organic unity* of this increasingly complex structure is maintained by the nerve cells and the structures which they constitute. In order that the more perfect sense organs and motor structures may be used to advantage, it is necessary that they be brought into *unity*. Stimulus and response must be coördinated. And thus, gradually, we find the emergence of a nervous *system*, whose ramifications reach every structure in the body, uniting the separate members into a single individual organism.

It should be noted that evolution is not always progressive. Numerous forms of life, such as the echinodermata and mollusks, have been halted in their development by too much, or rather by unbalanced, specialization. The shell of the mollusk protects it from its enemies, but it at the same time restricts the movements of the animal, prevents the development of an effective sensori-motor system, and confines the animal to a primitive form of life. There are endless species that have stood still or perished while the march of progress went forward through other and more mobile forms of vital organization. On the whole the specialization of sense capacities, nervous connection, and organs of locomotion and response has gone hand in hand with increased mastery of the environment by the animal.

In the lower multicellular animals we find, as might be expected, comparatively simple sensori-motor structures which confine these creatures to a limited repertoire of reactions. Their activities, accordingly, appear rather stereotyped and mechanical. Many scientists, indeed, believe that they are best interpreted as reflex machines. But we must not overlook the presence and significance of what may be called "exploratory" or "trial" activities on the part of these animals. They seem possessed of an inner restlessness that keeps them forever trying the qualities of their world. Professor S. J. Holmes has said: "The lives of most insects, crustaceans, worms, and hosts of lower invertebrate forms, including even the Protozoa, show an amount of busy exploration that in many cases exceeds that made by any higher animal." This exploratory restlessness becomes significant from the psychological point of view only when we find it combined with a capacity to *profit by past experience.* And this, in faint degree at least, the lower invertebrates seem to possess.

A sea-anemone which has been cheated several times with false food ceases eventually to pay any attention to it. Jennings has shown that the response of an earthworm to stimulation depends not only on the stimulus but on the internal state of the creature as well. Past stimulations and reactions leave a change in the organism analogous, perhaps, to the modifications which human muscle undergoes in course of being exercised. These internal modifications truly seem in some cases to be cumulative and relatively permanent, producing something analogous to new habits of response on the part of the animal concerned.

Professor Preyer experimented with star-fishes by pegging them down in such a way as to leave them uninjured. He found that the animals learn to escape from such traps by a process of trial and error. In course of time a large number of excessive movements are eliminated and the animals escape more quickly and effectively than at first. Many other examples might be cited to show the capacity of the lower animals to profit by experience.

In this ability to make exploratory movements, and to make "trial and error" adaptations to the environment, we find the foreshadowing of the plasticity of action and the memory of man. The activities of these animals might, indeed, be considered wholly mechanical in type, did we not discern in this primitive behavior the germs of adaptive behavior which comes to fruition in the higher species.

Instinctive Activity.—The evolution of animal life, after we leave the multizoa, takes place along two main branches, which have been called the "big-brained" type, culminating in man, and the "little-brained" type, culminating in the higher insects, such as the bees and ants. In structure the arthropods and vertebrates follow quite different plans. This divergence is most conspicuous, perhaps, in the nervous systems of the two types. In the insects the nervous system consists of a chain of ganglia situated in the separate segments of the animal's body and we find only a tendency towards the formation of a centralized control in the "head end." In the vertebrates, however, control comes to be more and more centered in the brain. And, as we follow the vertebrate line of development, we find increasing brain-size correlated with increasing intelligence. "Brain" and "mind," when referred to the species *homo sapiens,* are sometimes regarded by speculative psychologists as interchangeable terms.

If, however, we assign intelligence predominately to the mammalian vertebrates, we must likewise recognize that instinct is most highly developed in the little-brained types. Nowhere, of course, do we find instinct without intelligence or intelligence unmodified by instinct. The more highly developed insects, however, have ways of acting and knowing which lie beyond human comprehension. The life of instinct is so altogether different from our own conscious and deliberate behavior that we have not yet been able to penetrate it either by sympathetic intuition or by intellectual analysis. Instinct is, in so many respects, so precisely what intelligence is not, that they are scarcely commensurable.

The most characteristic aspect of the instinctive life, as it shows itself among the higher insects, is that it involves, in a peculiar sense, *specialized organic structure.* Instincts "are the functional correlatives of structure," says James. "With the presence of a certain organ goes, one may say, almost always a native aptitude for its use." Bergson adds: "The most marvelous instincts of the insects do nothing but develop its special structure into movements: indeed, where social life divides the labor among different individuals, and thus allots them different instincts, a corresponding difference of structure is observed: the polymorphism of ants, bees, wasps and certain pseudoneuroptera is well known. Thus, if we consider only those typical cases in which the complete triumph of intelligence and of instinct is seen, we find this essential difference between them: **instinct perfected is a faculty of using and even of constructing organized instruments; intelligence perfected is the faculty of making and using unorganized instruments.**"

The insect, that is, possesses a *special* bodily equipment which fits it to live in a particular environment. Through and through, part for part, the animal's structure is specialized. It knows, without being taught, how to use its special structures for spinning, gnawing, stinging, building paper or mud houses, sucking honey—or what not. What it is structurally fitted to do, that it can do "without previous education in the performance." And such things it *does* do, insistently, as if driven by an irresistible urge. Its life, consequently, is a deadly routine, unrelieved by play or by experiment. It depends for its preservation, and from the racial point of view, successfully, upon its inherited reaction tendencies, rather than upon learning and experience. William Beebe, writing in the *Atlantic Monthly,* gives us an excellent impression of the deadly uniformity and regularity of the life of instinct. He is telling about the Atta ants:

"On almost any trail, an ant can be found with a two-inch stem of grass, attempting to pass under a twig an inch overhead. After five or ten minutes of pushing, backing, and pulling, he may accidentally march off to one side, or reach up and climb over; but usually he drops his burden. His little works have been wound up, and set at the mark 'home'; and though he has now dropped the prize for which he walked a dozen ant-miles yet any idea of cutting another stem, or of picking up a slice of leaf from those lying along the trail, never occurs to him. He sets off homeward, and if any emotion of sorrow, regret, disappointment, or secret relief troubles his ganglia, no trace of it appears in antennae, carriage, or speed. I can very readily conceive of his trudging sturdily all the way home back to the nest, entering it, and going to the place where he would have dumped his load, having fulfilled his duty in the spirit at least. Then, if there comes a click in his internal time-clock, he may set out upon another quest—more cabined, cribbed, and confined than any member of a Cook's tourist party."

And again Beebe remarks: "As we have seen, an Atta worker is a member of the most implacable labor-union in the world. He believes in a twenty-four-hour day, no pay, no play, no rest—he is a cog in a machine-driven good-for-the-greatest-number. After studying these beings for a week, one longs to go out and shout for kaisers and tsars, for selfishness and crime—anything as a relief from such terrible unthinking altruism."

The development of instinct along the Arthropod line, then, follows a tendency which in the end leads to wide divergence between the insects and the vertebrates. What the inner character of instinctive mentality may be we can only dimly guess, by means of the insight which our own very limited instinctive equipment may give us. What we wish to emphasize, here, is that intelligence, as we understand it, follows a path that leads *away* from instinct; away from fixed structure and fixed responses, to *plastic* structure and adaptive conduct.

Vertebrate Intelligence.—The insects and the vertebrates, then, represent divergent tendencies in evolution. The insect has sought specific organic adjustment to its environment. Its evolution is in the direction of ever more complicated reflexes, fitting it to the relatively stable conditions of life which it may expect to meet. It has developed itself into an efficient reaction-apparatus which functions satisfactorily in a fairly stable environment. But let the environment undergo radical changes and the animal's equipment may become worse than useless. Nothing can be more helpless than an insect placed in an environment with which its reflex and instinctive equipment is not prepared to cope.

But while instinct runs to a specialized equipment and a sensori-motor system with locked switches, intelligence seeks a *generalized* structure and an indeterminate nervous system. The human hand, for instance, is fitted for a thousand and one kinds of activities: in this it contrasts sharply with a claw or pincer which has a limited or specific use. The whole human frame, indeed, is molded along general lines. Men possess no armor, no fur, no stings, no very special structures of any kind. But with his refined sensitivity, centralized nervous system, and a motor equipment that enables him to use tools and thus to control material forces to his own ends, man is indeed Lord of Creation.

This generalized capacity for reaction, however, requires a highly complex nervous system for its maintenance and effective use. Man can execute an almost endless number of complex acts, but *not by original nature.* Because he is constructed for many kinds of activities, he is expert at birth in only a few. In an instinctive animal nervous energy *must* follow the set and predetermined paths which energize the creature's special structures; but in man, where structure is general, rather than specific, the nervous system is left open, so that those modes of reaction which are to prove most effective in the individual's special circumstances of life may be *selected* and developed. The nervous system of the infant is, for the most part, a great unformed mass of potential sensori-motor connection. The human individual forms his own nerve-connections in accordance with the demands of experience.

There is no doubt that it is better to be a highly adaptable than a highly adapted animal. "In the present (human) environment," says Dewey, "flexibility of function, the enlargement of the range of uses to which one and the same organ, grossly considered, may be put, is a great, almost the supreme condition of success." And, indeed, in any environment the creature which has, not merely a great repertoire of possible acts, but also the ability to construct new complex acts to meet new situations, has a great advantage over organisms whose powers are limited by their too precise organic adaptation.

The higher vertebrates, however, and especially man, pay for their advantage by work, worry, and prodigal waste of individual energy. The long pre-natal period of the human infant is followed by helpless babyhood and years of slow growth and tedious learning. How sharply this condition contrasts with that of the purely instinctive creatures which emerge into the world fully equipped and educated! The later chapters of this book will be devoted largely to the study of the growth and attentive learning of the human individual. It is upon the learning process, indeed, that human psychology must inevitably center. Here let us fix attention upon the psychical aspects of that most significant evolutionary development, the emergence of the "big brain" with its plastic connections and centralized control.

Trial and Error.—We must consider, then, how the vertebrate animals profit by experience, and how, by trial and experiment, they succeed in building up new reactions to meet new demands. The tendency to explore, to test the world, is present even among the lowest animals, as we have seen, in the form of a somewhat undirected but persistent restlessness. We have seen, too, that experience tends to modify their responses—at least to a limited extent. These tendencies are manifested in increasing degree as we ascend the vertebrate line. Exploration and inquisitiveness become definitely experimental; the tendency to "stay with" novel situations, and to try to master them, becomes more and more evident; the tendency to utilize the past in dealing with the present becomes more pronounced; conduct becomes ever more resourceful and less routine.

Many experiments have been conducted, during the last few years, on the higher vertebrates. What has come definitely into the foreground as a result of these experiments is an understanding of the technique of "trial and error" learning. The general features of this type of responsive adaptation is well illustrated by Thorndike's experiments with cats and dogs. A hungry animal is confined in a puzzle box with food placed outside and in full view. Its first attempts to get out of the cage are usually haphazard or random, although persistent. The animal claws and bites at the bars, tries to squeeze through them or to get the meat by reaching out, tries its whole stock of reactions. Presently by a lucky movement the animal strikes a lever or pulls a cord and escapes. Repeated trials under the same conditions prove that the animal gradually learns to eliminate false movements, cutting down its time of escape from day to day, until finally it masters the trick completely.

In such experiments we see going forward a trial and error process of learning, in which many responses are tried and, by a process of elimination, the best finally selected. The method is costly in energy and time, besides being too slow to be available in critical situations. But, when habits are once formed, by such a method, they nevertheless remain a valuable part of the animal's reaction equipment and, we may suppose, open the way for the building up of still more complex forms of response to things. Because, however, the trial and error method of learning is costly, we find, among the higher vertebrates, a growing tendency to withhold overt action in favor of an *indirect* activity of *attention and observation*. Speaking of the results of his experiments on cats, Thorndike remarks: "After getting out of six or eight boxes by different sorts of acts the cat's general tendency to squeeze through holes and bite bars is weakened; accordingly it will learn associations along the general line of the lock much more quickly. Further, *its general tendency to pay attention to what it is doing is strengthened,* and this is something which may properly be called a change in degree of intelligence."

What is the significance of this attentive observation of things? The animal, instead of beating madly about in the hope of finding an adequate response to the stimulus, now makes the trial incipiently, by an inner process of experimentation. Watch a dog confronting a situation to which reaction is undecided. His tentative lunges along this or that line of action are visible in his sudden starts and inhibitions. Such tentative balancing and testing of motor response is often visible even in human adults.

Now human thought is nothing more than **an extensive development of this same capacity to withhold direct action in favor of inner or "mental" trial and error.** In this observation we have the key to an understanding of human intelligence, for throughout its range it remains (using Bosanquet's phrase) a form of *ideal experiment.* Thought begins with a problem, proceeds by elimination and selection, and ends with some kind of solution, tentative or overt. Ideal experiment, then, takes the place, in men, of the crude trial and error methods of lower animals. Human deliberation is, we must acknowledge, exceedingly complex, and involves the appearance of many new capacities. We shall be hard put to it to give a clear account of the reasoning processes in our later chapters especially devoted to that task. For the moment we may, perhaps, furnish a provisional answer to the inevitable question: what has the increase in size of the brain to do with this increased capacity to stand apart from a puzzling situation, observe it, and solve it by ideal experiment?

We have said that, as we move upward among the vertebrates, there is a gradual tendency away from segmental control to centralized brain control. The cerebral cortex takes over, more and more, a control, direct or indirect, of all the motor responses of the organism. It is in this centralization that we find the secret of our power to pause, to deliberate, and to decide before we act. Every important external motor function is brought into association with other functions, and thus made subject to *inhibition and control.* Centralized control makes possible "organismic" reaction, in which every motor tendency is balanced against others, so that the emerging act is the expression of an individual system.

Science and Reflection.—We should observe, before we close this outline sketch of the development of mind, that thought reaches its culmination not in mere deliberative thought, but in *self-conscious thought.* Man does not merely think; he *intends* to think. With us the whole business of experimentation, actual and ideal, has been elaborated to a tremendous degree. To the aid of systematic thought we bring language, symbols, mathematics, measuring instruments, methods of analysis, elimination, and selection of the most technical and elaborate kind. It sometimes takes years to master the intricacies of our scientific methods. In thus commanding and improving his own power of reflection man shows an ability that carries him far beyond the brutes. It has long been held that in this faculty of self-conscious reflection, of creative reason, we find the essence of the human and the roots of the divine. In this opinion there is undoubtedly much truth and sound substance.

CHAPTER III

REACTIONS AND THE NERVOUS SYSTEM

"Man is to himself the mightiest prodigy of nature; for he is unable to conceive what is body, still less what is mind, but least of all is he able to conceive how a body can be united to a mind; yet this is his proper being."—PASCAL.

"Action and reaction appears to be the great law, not less of the moral than of the material world."—ALISON.

The first thing that arrests the attention of the observer of human nature is, as a matter of course, a group of more or less organized reactions and reaction systems. That is, we see our companion doing something overtly with hands, feet, or vocal apparatus. Besides these there are other reactions in infinite number that can be observed only in specially prepared circumstances—by the aid of instruments of precision. These are the reactions of glands, such as the thyroid, adrenal, salivary, gastric, and others, and of the delicate constrictor and dilator muscles in the walls of arteries and capillaries that are active in blushing and in paling. The living organism is always in reaction. There is no absolute state of rest. What we call rest is but relative quiescence.

These are altogether processes by which the organism is adapted to the environment without and to its environment within. They are processes, that is, through which the organism finds satisfaction of its needs for preservation on the whole: for defense or protection in danger, for food and drink and propagation, and for social intercourse in its manifold forms.

What is a reaction? To say that it is a response is to express one's self tautologically, and yet that is about as well as one can do. It is a response, or what an organism does because of a stimulus or a situation that has been brought to bear upon one or more of its sense organs. *Stimulus* is described in a subsequent chapter as a form of energy that arouses a nerve impulse in a sense organ and a *situation* is described as a highly complicated group of stimuli.

Reactions fall into two great groups that are differentiated by the kind of adjustment that is effected by them, by the nature of the stimuli that induce them and by the processes that intervene between the stimulus and subsequent response. There is a region between them that is an indefinite border in which reactions partake of the character of each of the main groups.

The Reflex.—The first of these comprises the reflexes. These are unlearned responses: parts of the original nature of men. The clearest illustrations of the reflex are found in the eye-wink; the knee-jerk, the pupillary reaction to light and in numerous internal reflexes commonly called automatic actions, such as the beating of the heart, respiratory action, the churning movements of the stomach and intestines after food has been eaten, the jerking the finger away from a hot stove with which it has come into contact, coughing, sneezing, and the like, no one of which requires any preparation on the part of the reacting subject. It is characteristic of the organism that it is ready for these reactions the moment a fleck of dust falls upon the eye, or when the eye-ball surface becomes dry; the moment the lower edge of the knee cap is tapped with a rubber hammer or with the tips of the fingers; the instant the intensity of light falling upon the eye is altered and whenever there is a sufficient change in pressure of blood within the cavities of the heart.

The Simple Reaction.—The simple reaction, on the other hand, calls for a preparation in addition to the provision of anatomical structure and nervous energy. And this element of preparation is the only difference between the reflex and the simple reaction. It has no reference to the development of anatomical structure but to an elaboration of associational processes, especially in the cortex. The meaning of this will become clear in the course of the following description of the simple reaction-time experiment. The reactor's "preparation" consists in grasping the situation.

The problem in a test of simple reaction time is to determine how quickly one can do a simple thing in response to a particular stimulus. For example, how quickly can one release the pressure of one's finger from an electric key after an auditory stimulus has been received from the sudden impact of one piece of metal falling upon another? The time is usually measured by a chronoscope that is set going the instant the two pieces of metal come into contact and thereby complete a circuit through the key and the time-piece. The circuit is broken and the chronoscope is stopped the instant the electric key is released. The intervening time as indicated by the clock dial is the simple reaction time. The stimulus may be a shock of sound or a flash of light or any other sensory stimulus. The time will vary somewhat with the stimulus, with the physical condition and emotional state of the subject at the moment, and with the preparation he has received at the hands of the operator. For instance when the stimulus is sound the reaction time may be 0.15 sec., and 0.18 sec. when it is light. These figures may be reduced somewhat in the course of practice, but probably never to so low a figure as 0.05 sec., the approximate time required for the eye-wink, or to 0.03, the knee jerk time. The difference between the two times suggests, among other things, a difference in the anatomical structures involved, and possibly in their extent.

The Discrimination Reaction.—The discrimination reaction presents a somewhat different situation. Here there are two or more simultaneous stimuli, only one of which is to be reacted to. For example, suppose the stimuli are colored lights and that in successive tests one of the following pairs is presented: red and yellow; blue and green; white and purple; yellow and white; suppose further that the subject has been instructed to react only when a yellow light appears in one or another combination. This is a discrimination reaction and what is usually called the choice reaction is very like it. For illustration, if a subject is instructed to react with his left hand when red appears and with his right when yellow is presented, the response will be a choice reaction. It is longer than the simple reaction by about one tenth of a second. The nervous energy in such cases as this, as we shall see later, has to travel a longer way and over a more winding road than in the case of the simple reaction. This accounts for the longer time involved. The preparation between stimulus and response is more elaborate than in the preceding case.

The Association Reaction.—Then there is the "association reaction" that is approximately one tenth of a second longer still. When a series of words is pronounced to a subject and he is instructed to react to each one in turn by writing or speaking the first other word that comes into his consciousness the result is an association reaction. Here the preparation is more elaborate still. It consists in the subject's apprehension of instructions and in his acquisition of a variety of experiences that are capable of being represented in ideas and images aroused by the stimulus.

Reflexes and Other Reactions Compared.—It has already been implied that the reflex requires less time than other reactions. But a more essential difference is that the organism is always ready for the reflex whereas it requires some preparation in order that other reactions may be made at their best. It is for this reason, and because the nerve connections involved in reflexes are more direct than those in other reactions that, on the whole, the reflex is the quickest type of reaction.

Voluntary Reaction.—Voluntary reaction involves the maximum of preparation between stimulus and response. It may involve a period of long delay during which the subject is, as we say, analyzing a situation: he is weighing the advantages and disadvantages of this and that alternative. In a word, he is thinking and arriving at a conclusion. This all involves brain action of infinite complexity which is conceived as finally tipping the scales in favor of one form of action as opposed to others—or possibly in favor of omission of any form of action: inhibition. When finally the moment of action, if any, arrives, the mechanism employed in executing it is precisely that which is employed in reflex actions.

This type of reaction and others called habits and still others called instincts, will come up for more complete consideration in separate chapters.

The Nervous System.—This brings us to an account of the nervous system by the function of which all reactions are made to occur. This is an enormously complex network of lines of communication and of relay stations, so to speak, by way of which nervous energy is carried to the muscles and glands of the body from sense organs and from the brain and ganglia outward to the muscles. It may be conceived after analogy with a telephone system which serves to bring speaker and hearer together, not directly but indirectly through a switchboard. So the nervous system serves to connect a sense organ with a muscle or with a gland through a central organization that sends each nerve impulse or specific quantum of nervous energy out to the proper destination.

Neurones and Synapses.—The elemental unit of the nervous system is the neurone. This consists of a nerve cell and its appendages, the axone and the dendrite. These are more or less branched filaments of nerve tissue that extend in opposite directions from the cell. The dendrite is more numerously branched than the axone. It resembles a treetop with its irregularly branching limbs oblique to its stem. The axone is less branched and its limbs are approximately at right angles to the stem. Neurones are of many forms and they vary in length from a few inches to four or five feet. Their diameter is so small that a microscope of high power is required to enable one to see a cross section. Their number has been estimated at 3000 millions.

For our purposes the neurones are the essential, though not the only, constituent of the nervous system. Their delicate filaments are the carriers of the nervous impulse from sense organs to the central system (brain or spinal cord) or from the central nervous system outward to the muscles of the body. To use a simple figure we may say that they are the individual telephone wires that are bound together in a bundle and protected by a tube or a sheath.

Nervous energy always passes over these neurones in the same direction: dendrite to cell to axone and into the dendrite of the next neurone, for they are arranged serially. The point of passing over from one to the next is called the *synapse*. There is no anatomical connection here—that is the tissue of one does not run into that of the next—but a functional connection only. We shall have occasion to speak of the synapses later.

Nervous Impulse.—We have used the phrase "nervous impulse." Whatever this is, it "flows," at least figuratively speaking, over the nerve fibers. It cannot be a mechanical transmission of energy from molecule to molecule or atom to atom of the nervous system such as occurs when one billiard ball strikes another. The passage of a nervous impulse is too rapid to allow us to conceive it in this manner. On another hand it is not rapid enough to allow the hypothesis that it is electrical in nature. The prevailing hypothesis is that the nervous impulse is an electro-chemical process that goes on throughout a nerve fiber and its connections whenever an adequate stimulus has been presented.

We have said that the nervous system is a complicated arrangement of nerve fibers and cells and ganglia by means of which sense organs are connected with muscles and glands. We will now attempt to describe this system in its main outlines.

Mechanism of the Reflex.—The diagram below illustrates schematically the connections that are involved in a reflex in which the stimulus has been applied to the back of the hand. The arrows indicate the course of the nervous impulse, inward from the hand to a center within the dotted boundaries and thence outward to the muscle in the upper arm (the biceps) by the contraction of which the hand is removed from the stimulus. It will be seen that the following parts are included in this connection: (1) a sense organ,

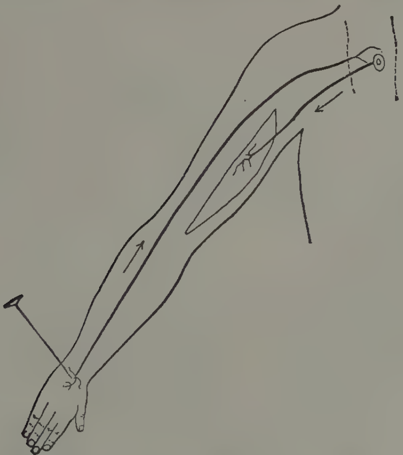

FIG. 3.—The connection from the back of the hand, which is receiving a stimulus, and the arm muscle which makes the response. The nerve center is indicated by the dotted lines. (After Woodworth.)

(2) a nerve fiber that carries the impulse to the center—the sensory or afferent fiber—(3) the center itself and (4) the nerve fiber that carries the impulse outward from the center to the muscle—the motor or efferent fiber. The inward going and the outward going impulse, respectively, are called the sensory and motor impulses. The four parts just mentioned together comprise the reflex arc. Some such arrangement as this, usually much more complex, is involved in every stimulus-response. In the case of the reflex the impulse is almost instantaneously switched at the center from the afferent to the efferent fiber. We shall see, however, that in many other instances a long delay occurs here as when one takes time to decide what form the response shall take. This phenomenon suggests that other centers outside the one immediately involved are a control upon it.

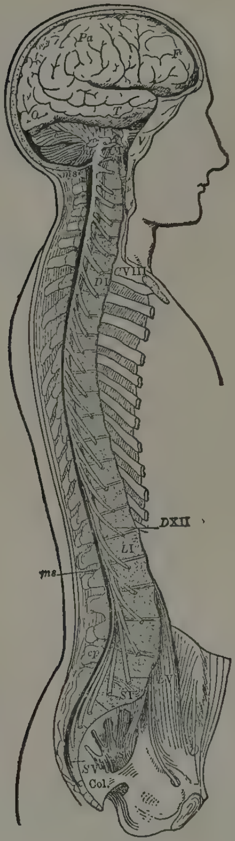

Fig. 4.—Brain, spinal cord and nerve roots.

A longitudinal section through the medial plane of the spinal column, and in part of the skull. Lobes of the cerebrum, *Pa*, parietal; *F*, frontal; *O*, occipital; *T*, temporal; *C*, cerebellum; *mo*, medulla oblongata; *C*I—*C*VIII, cervical nerves; *D*I—*D*XII, thoracic nerves; *L*I—*L*V, lumbar nerves; *S*I—*S*V, sacral nerves; *Col*, coccygeal nerve; *ms*, *ms*, upper and lower extremities of the spinal cord.

It is customary to describe the central nervous system and the sympathetic or autonomic nervous system as two distinct organizations. And indeed, in large measure they are so. The central system is more directly in control of our overt behavior: reflex, habitual and voluntary and of our activity of consciousness. The sympathetic system is more directly in control of internal reactions, such as of the heart, respiratory organs, the muscles in the walls of the stomach and intestines and of blood vessels which occasion our blushing and growing pale. It is in control, too, of the glands of internal and of external secretion. The two systems are not wholly distinct. Their anatomical contact and communication will be pointed out later.

The Central System.—For convenience we may think of the central system as of several parts: brain, basal ganglia, spinal cord and their inlets and outlets called the peripheral nerves. The peripheral nerves fall into two groups; spinal and cranial. There are thirty-one pairs of spinal nerves. Each pair is composed of an afferent trunk which carries sensory impulses from the sense organs in the skin, muscles and joints to the spinal cord and an efferent trunk which carries motor impulses from the centers to the muscles. The cut above shows these parts in relation to one another.

There are twelve pairs of cranial nerves. Some of these comprise only motor fibers and others sensory fibers alone. Still others comprise both motor and sensory fibers. They are numbered from I to XII. Their names and functions are as follows:

I	Olfactory	Smell.
II	Optic	Vision.
III	Oculo-motor	Motor and sensory to eye muscles.
IV	Trochlear	Motor and sensory to eye muscles.
V	Trigeminus	Sensory from skin, mouth and teeth.
VI	Abducens	Motor and sensory to eye muscles.
VII	Facial	Taste on anterior part of the tongue.
VIII	Auditory	Hearing and equilibrium.

IX	Glossopharyngeal	Taste on back of tongue.
X	Vagus	Motor and sensory to viscera.
XI	Spinal accessory.	
XII	Hypoglossal.	

The Spinal Cord.—A diagram of the spinal cord in cross section is shown in Figure 5.

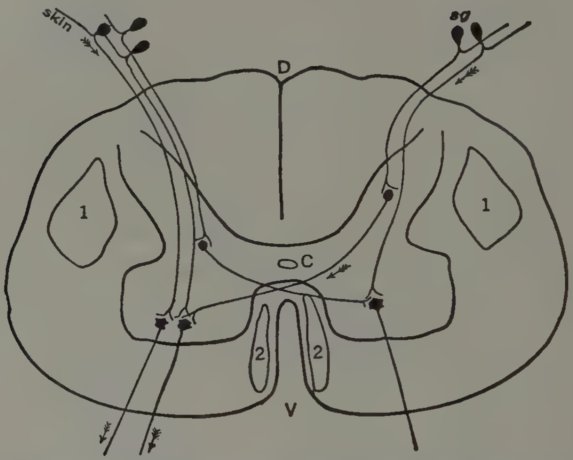

FIG. 5.—Cross-section of the spinal cord. The inner H-shaped figure gives the outline of the gray matter. The remainder is white matter. D, dorsal; V, ventral; *sg*, spinal ganglion; C, spinal canal; 1, 1, are crossed pyramidal tracts containing fibers from the pre-Rolandic area of the brain; 2, 2, are direct pyramidal tracts carrying the same type of motor nerve fibers from the brain. The crossed fibers cross from one side to the other of the cord in the region of the medulla. The direct fibers cross at lower levels. The arrows show the direction of the nervous impulse. (After Hunter.)

The arrows indicate the direction of the nervous impulses. The central portion of this figure—roughly in the form of the letter H—represents the gray matter of the spinal cord and the outer portion, the white matter. The latter is composed of fibers that transmit impulses upward or downward to or from the brain. As the legend below the figure indicates, the bundles of fibers that carry motor impulses from the brain are at 1 and 1 and at 2 and 2. The former are the crossed fibers: that is, those on the right side of the cord have come over from the left side of the brain in the medulla and vice versa. The latter are the direct or uncrossed fibers. Even these, however, always cross over before they leave the spinal cord on their way to the muscles that they control, so that the left side of the body is controlled from the right side of the brain and vice versa. We are speaking here of cortical impulses and cortical control.

Earlier in this chapter we were speaking of the reflex reaction. The structures in the spinal cord that are involved in this type of behavior are exclusive of the crossed and the direct tracts to which we have just now alluded. They are a certain afferent fiber leading from the sense organ that has been stimulated into the posterior portion of the cord (see Figure 5), an efferent fiber leading from the anterior portion to the muscle that is reacting, and the connecting cells between these two in the gray matter of the spinal cord. The incoming and the outgoing fibers may be at the same or different levels, or two or more levels. In the very simplest form of reflex the incoming and outgoing fibers are at the same level. In the more complex cases other tracts are involved in addition to those already mentioned, that carry impulses upward or downward in the spinal cord. A complete picture of all these connections would be very complicated.

Before leaving this subject we must mention one other large group of fibers within this portion of the central system. In the diagram above (Figure 5) is the large unmarked area in the posterior region bounded by the horns of the letter H. Here are bundles of white fibers that carry sensory impulses to the brain. Without them we could not be aware of the stimulation of sense organs in the trunk and extremities of the body. Each of these structures is so well defined and its function is so well known that, by a study of reflexes, a diagnostician may determine very accurately where among them a degeneration has occurred.

Action of the Spinal Cord.—We will now try to obtain a general idea of the way in which the spinal cord functions in relation to behavior. In doing so we shall have to refer very briefly and superficially to the action of the brain also. Let us suppose that the index finger of the right hand has come into contact with a hot stove. A sensory impulse is aroused in the sense organs in that finger; it is carried over the afferent fibers and enters the cord on the same side and in the posterior aspect. Thence the impulse travels through the gray matter on the right and as a motor impulse it emerges from the anterior aspect. This impulse proceeds over the efferent tract to the muscles that control the behavior of the right hand and it is withdrawn from the stove. The whole process consumes but a small fraction of a second. But the behavior may be much more complicated than this. The hand may be waved in the air; the left hand may be swung about also, indicating that the sensory impulse has spread over from the right to the left side and that it has emerged as a motor impulse from the left anterior aspect of the cord as well as from the right and that it has excited the muscles on the left to contraction.

Up to this moment we have an illustration of a reaction involving but one level of the spinal cord. But the excitation is not always so hedged in. It may spread to lower levels when motor impulses will go out to the muscles of the trunk, and the body is made to writhe. It may descend still farther to those centers in the cord from which the legs and feet are controlled and cause us to dance about upon the floor. Not only so, the excitation that arose in the stimulation of the finger may make its way upward to the cervical region and to the medulla oblongata. Then we catch our breath: our respiratory organs are in spasmodic activity; motor impulses go out even to our vocal organs and we scream aloud. The whole motor mechanism of the body is involved in strenuous activity at last, all as a result of a simple stimulus that has aroused the function of the spinal cord alone.

At the very beginning of this violent activity the behavior is without consciousness. The hand has been got away from the stove before there is any awareness of what is going on. But long before the whole body has become involved in action there is vivid awareness—perhaps not of every detail of movement—but of the situation as a whole. Then an interesting thing takes place: it "occurs" to us that we are unmanly—making so much ado about a little burn upon a finger tip—and we settle down to a quiet state. This is a sign that the brain has got into action. The excitation in the cord has been communicated to the brain; there memories of concrete illustrations of courageous behavior, possibly, have been aroused or more generalized ideals of manly conduct have come to the fore. At any rate the brain is now exercising a control over the spinal cord action: putting on the brakes here and turning on the steam there. But we shall turn to the brain and its function later.

The Medulla.—The medulla oblongata is the upper continuation of the spinal cord (see Figure 4). It conveys nervous impulses from the cord to the brain—the cerebrum and cerebellum—and from these parts, in the reverse direction, to the cord. It contains the groups of nerve cells that control the acts of breathing and circulation. These cells are stimulated by certain variable contents of the blood: for example when the carbon dioxide supply becomes abnormally high as when one is smothering, the cells referred to are excited and this results in increasing the rate of heart beat and respiration.

The Cerebellum.—The cerebellum is the mass of brain tissue that is represented in dark shade in Figure 6 about the upper end of the spinal cord. The gray tissue, such as forms the core of the cord, is upon the outer surface of the cerebellum, and the white tissue is within. This tissue is known as the cortex. The cerebellum is in two parts or hemispheres. They are connected by a bundle of white nerve fibers known as the pons. It is connected by many fibers with the medulla and the mid-brain. The chief function of this portion of the brain is the maintenance of bodily balance. If it is taken away from an animal it is wholly unable to maintain its equilibrium. It plays its part in the maintenance of balance by reason of receiving sensory impulses from skin, muscles, joints, semicircular canals of the ears, and from the eyes. The stoppage of any one of these sources of nerve supply interferes greatly with equilibrium. A simple demonstration of this fact may be had by anesthetizing the soles of one's feet or the feet of one's dog. In fact the "sleeping foot" affords an additional illustration. In each of these cases the normal supply of sensory impulses is lacking and the cerebellum, therefore, does not have, so to speak, sufficient raw material to work with. If one attempts to stand with closed eyes the body sways far more than if the eyes are wide open. In this situation once more the cerebellum lacks its full supply of sensory material. Finally if the semicircular canals are put out of commission there is a profound disturbance of one's balance. This sometimes, though rarely, occurs in the course of surgical operation upon the mastoid and repeatedly the condition has been experimentally produced in physiological laboratories in the course of work upon pigeons and other animals.

Impulses from the cerebellum serve also to maintain muscular tonicity (a state of constant contraction) throughout the body and in this way it contributes to snappiness and precision in voluntary movement. There is no evidence that the activity of this portion of the central nervous system is directly correlated with consciousness.

The Mid-brain.—The mid-brain contains the corpora quadrigemina, whose function is to control the auditory and visual reflexes such as the action of the tympanic muscle that governs the tensity of the ear drum; of the pupilary muscle that dilates and narrows the pupil of the eye and of the ciliary muscle that governs the curvature of the lens. Sensory impulses from eyes and ears enter, in the mid-brain, into connection with many motor neurones that lead out to the face, eyes, and other parts of the body.

The Thalamus.—The figure below, representing a transverse section of the brain with the forward portion removed, shows the thalamus at the center of the brain mass. Sensory impulses from every part of the body excepting those from the olfactory organ, pass through this structure on their way to the cerebral cortex. It is probable, too, that in the thalamus each impulse by reason of association with other impulses undergoes a considerable elaboration. Between the thalamus and the brain surface is the *corpus striatum* through which all impulses must pass after they have left the thalamus. In this region, too, just as in the thalamus an elaboration of sensory impulses probably occurs. In both the thalamus and the corpus striatum are correlation centers through which impulses may be diverted from sensory to motor neurones. In such cases reflexes are the result and the very highest levels in the nervous system are not involved.

The Cerebral Cortex.—The cerebrum comprises the great mass of the brain. The mid-brain, the thalamus and the corpus striatum are at its core. Its surface is convoluted elaborately and the convolutions are separated by a maze of fissures. The surface is the cortex: a layer of gray matter about 4 mm. thick rising over the convolutions and dipping into the fissures. The figure below, representing the cerebrum in transverse section with the forward portion removed, shows the cortex (the shaded irregular outer portion in the figure) and its topographical relations to the centers we have been describing.

For convenience we should observe three great fissures in the brain surface: (1) the median fissure that divides the brain mass into two hemispheres; (2) the fissure of Rolando, on both right and left hemispheres extending from the median downward and forward about midway of the anterior and posterior surfaces and running almost to (3) the fissure of Sylvius extending obliquely upward at an angle of about 45° on each hemisphere, from a point on the lower surface nearly midway of the anterior and posterior surfaces.

Neural processes in the cortex are correlated with consciousness. Unlike the cortex of the cerebellum that of the cerebrum is highly differentiated as to function. Forms of consciousness are not uniformly correlated with the activity of all portions of the cortical area. The posterior portion on both right and left halves, or hemispheres, of the cerebrum is the visual area; that is, it is correlated with the consciousness of things seen and things imagined in visual terms. Below the fissure of Sylvius on both right and left sides is the auditory area; and neural processes in the region are correlated with auditory consciousness. Directly behind the fissure of Rolando are areas that receive sensory impulses from the skin, muscles, joints, tendons and viscera. The cut above makes these relations clear. Suffice it to say that consciousness of stimulation of the foot, *e.g.*, can arise only when sensory impulses aroused by touch upon the foot have reached a particular cortical region behind the Rolandic fissure.

The shaded area in front of the fissure of Rolando in the figure below represents the motor areas of the cortex. That is, these are the areas from which motor impulses go out to initiate and control voluntary movements. Reference to the figure will show that such impulses as are destined for the thigh and trunk go out from the uppermost portion of the cortical area and that such impulses as are headed for the larynx for the control of voluntary speech go out from a small area in the obtuse angle between the fissures of

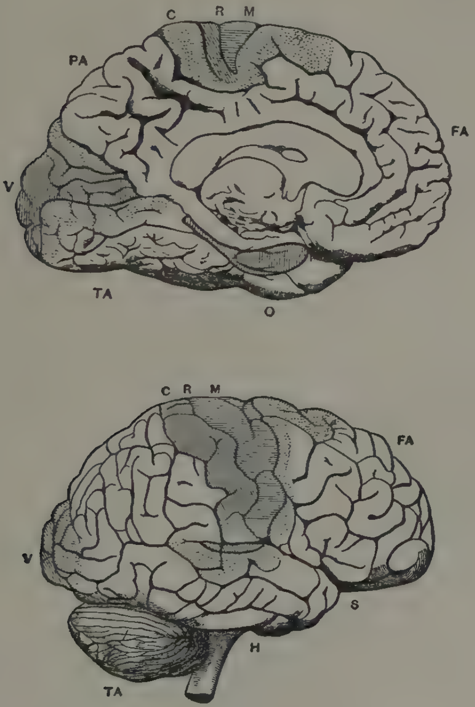

Fig. 6.—Localization of cerebral function. The lower figure shows the outer surface of the right hemisphere; the upper, the mesial surface of the left hemisphere.[1]

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[1] Pillsbury's The Essentials of Psychology. Copyright 1922 by The Macmillan Company. Reprinted by permission.

Rolando and Sylvius. Other portions of the body are controlled from intermediate areas represented in the figure.

The unshaded portions of the figure represent areas upon the brain surface to which no such definite functions belong. It is better to say that well defined functions have not been discovered in these regions. They are known as association areas. They probably contain a multitude of connecting links among the specialized areas mentioned above and between them and the spinal cord tracts: such connections are vastly intricate.

Aphasia.—The functional pattern to which we have been referring has been made out principally by two methods: the method of fiber staining and the physiological method. The latter is of more interest to students of psychology because it involves the observation of the behavior of animals and men in various states of cortical disturbance: disturbances that have been produced by vivisection in the laboratory, and other disturbances that have been brought to pass by accident, by localized brain hemorrhage or by pathological process of degeneration. Such observations have led to the definition of various forms of aphasia. For instance, if the area for voluntary control of the larynx (see Figure 6) is by any cause put out of commission the patient is not able to speak voluntarily. He may know perfectly what should be said; he may make himself understood by writing or by gesture, but speak he cannot, excepting for involuntary verbal expressions—words and phrases that are highly mechanized, such as "good morning." This represents what is commonly called motor aphasia. Similarly one is unable to write voluntarily when the writing area is disturbed; a condition known as agraphia. This is not inconsistent with ability to speak. If any other motor area is disturbed the person so afflicted loses the capacity to perform the corresponding motor function.

Other forms of aphasia are of the sensory sort. If the visual area is unable to perform its function by reason of a hemorrhage and consequent blood clot upon it or other cause, the patient is unable to recognize things seen or to imagine in visual terms—to see things in his "mind's eye." He may continue to see the objects in a room, for instance, so that he can walk across the floor without stumbling over them; but they are merely "something there." He is a victim of visual aphasia. Auditory aphasia and similar disturbances in other departments of sense are conditioned in like manner. A patient may hear without recognizing what is heard.

But the disturbance of function is not so clear-cut as the foregoing account may seem to indicate. A victim of visual aphasia, for example, may suffer some disturbance of the speech function and vice versa. Some upsetting of the writing function and of other motor behavior may be involved also; and one must speak in similar terms in describing a situation in which the auditory cortical center is the primary seat of disturbance.

All this means that brain function is not chopped up into parts, each of which is shut off in its own air tight compartment. The brain is a unit and it acts as a unit. This it is enabled to do by reason of an intricate maze of connecting tracts, a very few of which have already been sketched. When we describe a certain area as visual we mean only that this is the portion of the cortex that receives sensory impulses over the optic nerve and that there the cortical activity peculiar to vision is most pronounced. But the visual consciousness always contains elements whose neural accompaniments are widely distributed throughout the cortex.

Association Paths.—We have already referred to association paths in the cortex as connecting one area with another and all together in one intricate system. The conception is essential to make an account of the nervous system really significant. It is a profitable exercise to trace out schematically the pathways followed by nervous impulses in simple types of behavior. For example, when we

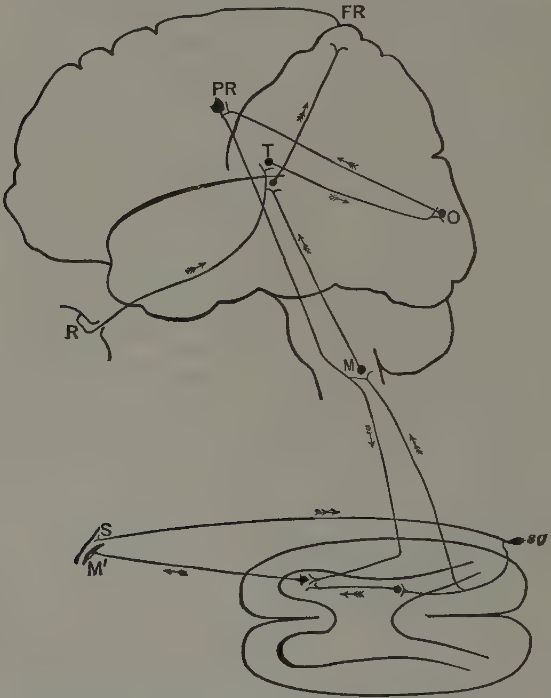

Fig. 7.—Probable pathway of a nerve impulse underlying a simple response. R, retina of eye; T, thalamus; O, occipital lobe; PR, pre-Rolandic area; M′, muscle; S, skin; *sg*, spinal ganglion; M, medulla; FR, fissure of Rolando. (After Hunter.)

see an object and voluntarily reach for it with our right hand; having touched the object we reflexly grasp it and we have the consciousness of seeing and of touching the object. What are the neural pathways that are followed by the impulses in this behavior? Reference to the figure above will assist in answering this question. The impulse is aroused in the retina and sets out thence to the thalamus and from here to the occipital lobe. Then we see the object and know what it is. The impulse then passes over an association neurone to the pre-Rolandic area whence another neurone carries it to the anterior horn of the spinal cord at the level of the hand. Yet another neurone carries it to the muscles that control the hand and we have touched the object. The contact arouses a sensory impulse in an organ of touch and it is despatched over a sensory fiber to the dorsal horn of the gray core of the spinal cord. A part of this impulse is carried over to the ventral horn on the same side of the cord and goes back to the muscles of the hand, and, once having activated them, the object is reflexly seized. Another portion of the sensory impulse is carried upward, is transferred to the medulla and thence to the thalamus. From here a third neurone carries it to the post-Rolandic area—to the cells that function in relation to touch upon the hand—and, once it has arrived there, we are conscious of having touched the object. By dint of further associational cortical processes we are next aware of the nature of the object. The figure above will asist in making these relations clear.

It should be remembered that this is only a sketch and that many neurones are involved where we have mentioned but a few, even in so simple a form of behavior as we have described.

Autonomic Nervous System.—To this point we have been thinking exclusively of the central nervous system. The autonomic is an outgrowth of the central system. Turn back to Figure 4. On each side of the spinal cord every bundle of spinal nerves is two-branched. This is not shown in the figure. Only the main stem appears. Here are the points of connection between the two systems. Certain neurones with one extremity in the central system pass over here and terminate in the autonomic system. These relations are made clear in the drawing below.

The branchings mentioned on the preceding page are parallel to the spinal cord. Here are ganglia, or functional groups of nerve cells that constitute the sympathetic division of the autonomic. They are connected with the spinal and cranial nerves by way of fibers that emerge from the cranial, thoracic and lumbar regions. From these ganglia other fibers arise that are diffusely distributed to the viscera of

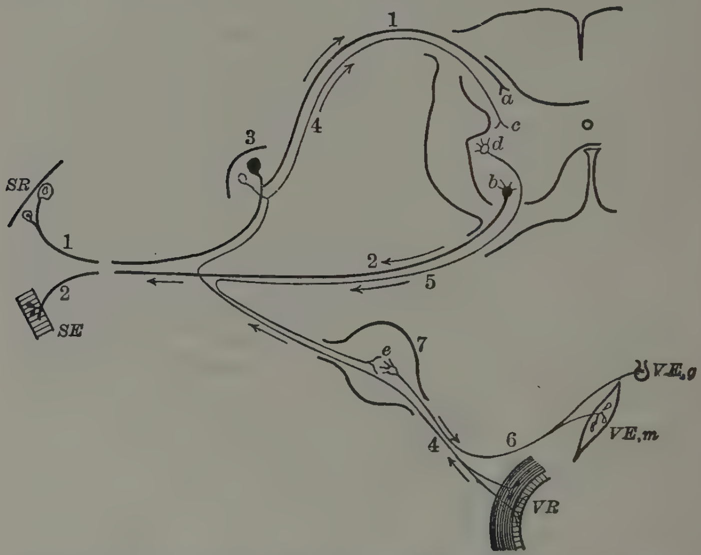

FIG. 8.—Relations of neurones in the cerebro-spinal and autonomic systems.

Somatic (cerebro-spinal) neurones shown in heavy lines, visceral (autonomic) neurones in light lines. 1, *afferent somatic* neurone; 2, *efferent somatic* neurone; 3, spinal ganglion; 4, *afferent visceral* neurone of the sympathetic; 5, *efferent visceral* neurone (pre-ganglionic); 6, *efferent visceral* neurone (post-ganglionic); 7, ganglion of the sympathetic; *SR*, somatic receptor (sense organs in skin); *VR*, visceral receptor (sense organs in viscera); *SE*, somatic effector (striped muscle fiber); *VE*, *m*, visceral effector (smooth muscle fiber), *VE*, *g*, visceral effector (gland). (After Allport.)

the body. Still other fibers arising here return to the spinal nerves and are distributed to the hairs, sweat glands and blood vessels upon the outer surface of the body. When our hair stands on end, when we sweat in fear or excitement, and when our skin ''creeps'' at night as we pass the ''haunted'' house, the fibers of the autonomic system are doing a bit of their proper work.

Others again pass through ganglia in the head region to the structures that are innervated by a second part of the autonomic system, the cranial division. The lens muscles, the iris of the eye, the salivary glands, the digestive system, bronchial tubes and heart are supplied from this section of the autonomic. When the pupils of our eyes, for instance, grow wide in the dark and narrow in the light it is evidence that the autonomic system has not failed us.

A third division of this system arises from the lower end of the spinal cord. It is known as the *sacral* division and its function is to accelerate organs of emission: the bladder, rectum and sexual organs.

The sympathetic on the one hand and the cranial and sacral divisions on the other hand play a part in controlling the same mechanism but they act in opposing directions. The sympathetic, for instance, dilates the pupil of the eye and the cranial division constricts it: the sympathetic inhibits digestive activities while the cranial and sacral divisions accelerate them.

The autonomic and the cerebro-spinal or central systems are not independent. They are mutually related and are anatomically connected by way of the pre-ganglionic neurone that has already been referred to as passing over from the central system.

By reason of its close functional relation to visceral action, to glandular activity, the circulation, etc., the autonomic system has an important bearing upon our emotional life and upon mental and bodily health. Its connection with the central system affords the avenue by which our states of emotion and mental and bodily health and disease may be brought under at least a minimum degree of voluntary control.

CHAPTER IV

HABIT

> "By doing just acts we become just, and by doing acts of temperance and courage we become temperate and courageous. . . . in a word, acts of any kind produce habits or characters of the same kind."—ARISTOTLE.

Habit Defined.—Human nature has its constants and its variables. The term *habit,* as it is commonly used, has reference to the fixed—as contrasted with the variable—elements in man's behavior. Habitual acts are such as are performed alike again and again in the presence of the same stimuli, or which seem to spring from some established tendency in the individual's make-up. Habitual conduct, in a word, is conceived as the resultant of constant factors in human nature. We must add this qualification: *habit* is employed in its most exact sense to refer to *learned modes of response,* as distinguished from those which are native or instinctive.

The conception of habit, as implying the constants and invariables in human behavior, has been extended in modern times to all phases of man's nature. Psychologists tend to explain, not only overt action, but likewise attention, perception, association, will, memory, by reference to habit. Now it is true that no explanation of such processes would be complete without some account of the fixed tendencies and structures which condition them, and in the later chapters where we take up these topics we shall have occasion to refer to the "constants" that are involved. We may be permitted, however, to confine our attention for the present to habit in its more restricted sense as denoting a form of conduct or overt behavior. We will mean by habits specific learned ways of acting that have become established and confirmed. We must try to understand how these are formed, how they are maintained, what they lead to and what they make possible.

We may take occasion here to remark that the use of habit as a universal and exclusive principle of explanation is not justified in our view, since the habitual modes of conduct are defined—conventionally—by contrasting them with ways of acting that are novel and spontaneous. Physical modes of explanation, which have been extended at times all too uncritically to human nature, introduce the notions of inertia and repetitiveness as basic concepts. But in psychology the idea of plasticity is equally valid and significant. Attentive activity, as we are to discover, is not repetitive or governed by ''determining tendencies,'' but is rather non-repetitive and creative. Learning, in a word, is not repeating; reasoning is something more than a form of response to familiar stimuli.

The Central Problem in Habit Formation.—It is necessary for us to understand, in approaching the study of habit, that were man a wholly mechanized being, with senses and motor organs linked together—natively—by a system of predetermined nervous connections, the question, How are habits formed? would be idle and pedantic. But the fact is that we *learn* to do things, very often by painstaking effort. Our sensori-motor arcs get shaped and polished by practice.

The number of reflexes with which man is endowed by his original nature is considerable if we take into account the automatic processes of the body. Swallowing, digestion, assimilation, breathing, heart action, glandular activity, these processes are set from the beginning to work by themselves. We have in addition a considerable number of overt reflexes—set to respond to external things—which are predetermined by our bodily structure. These native ways of acting, which have often been called "racial habits" are in many respects similar to our acquired habits, but are nevertheless quite different when we consider their genesis and the degree to which they are subject to voluntary control. We hold ourselves responsible for our acquired habits: we can inhibit, confirm, or reconstruct them. We can displace old habits with new ones. Habit, in a word, stands in intimate relationship to consciousness, and hence holds a peculiar interest for the psychologist.

Or, we may say, habit is of importance to the psychologist precisely because we are not exclusively "creatures of habit." Habit stands, in the plane of action, directly opposed to the original voluntary activity which enables us to meet new situations effectively, or to solve problems. But while thus opposed in conception—action habitual and action creative—habit and thought are nevertheless intimately related. They are, in short, mutually dependent phases of our human activity. We must attempt to understand how they bear upon one another. But first, we must undertake to characterize habitual behavior.

Habitual Behavior Described.—Fixed habits, according to Stout, have four chief characteristics: Uniformity, Facility, Propensity, and Independence of Attention.

Habits are *uniform.* They are, that is to say, performed always in the same way in the same circumstances. Such activities as putting on a coat or lacing the shoes are performed—normally—according to a fixed routine, involving on each occasion pretty much the same successive acts and attitudes. They are stereotyped. Such activities are often called "secondarily automatic," because in their machine-like precision they resemble the primary vegetative activities, like swallowing or breathing. Given the proper stimulus in the proper situation, habits unroll themselves according to a fixed pattern which is relatively unvarying. But, to be sure, no human activity is absolutely mechanical—not even the beating of the heart.

Facility is the second important trait of habitual conduct. Compare the smooth and fluent writing of a teacher of penmanship with the fearful efforts of a small boy beginning to learn, or the strenuous efforts of a learner in golf with the smooth efficiency of a professional. Habitual action goes straight to its mark, with a minimum of wasted effort and energy. But voluntary activity, involving as it does painstaking effort, is accompanied by a great excess of bodily movement, much of it as useless as it is exhausting.

The possession of a habit, again, implies a *propensity* to use it. "We are prone to do," says Stout, "what we are used to do." In the presence of the stimulating circumstances which are its established excitant a habit tends to go into action. If restrained at all it must be held in leash by positive inhibitions. Habits may be compared to well-worn channels along which our vital energy naturally flows when released. Who has not, on frequent occasions, caught himself performing some habitual act in its natural setting when such action should, in propriety, have been restrained? In the case of habit the reflex pathways between sense organs and muscles are open and ready. When the proper stimulation is given the motor activity follows unless restrained.

Habit is *independent of attention.* We perform habitual acts without "noticing what we are doing." Our coat somehow gets buttoned, our bread gets buttered, without attention on our part to the specific details of these acts. But we must not exaggerate. We may go on lacing our shoes or playing the piano, thinking meanwhile of other things, but attention is never far off. Although it does not take control (if we may use such a figure of speech) it keeps its eye on the process. Thus, in piano playing, although the fingers seem to act almost on their own volition, still complete independence of attention is not achieved. Attention governs the process as a whole, although its details are left to habit, and attentive consciousness may break in at any moment upon the details. But we must warn ourselves once more against setting up a complete dualism of thought and habit.

The Basis of Habitual Behavior.—Now this uniform, facile, non-attentive form of behavior must be grounded, we suppose, upon fixed or relatively fixed elements in man's natural make-up. We would most naturally expect to find these "constants" in the nervous system, as studied and interpreted by the physiologists. Habit depends, we have already suggested, upon the establishment of fixed nervous pathways between sense-organs and muscles. While we emphasize the nervous system we ought at least to observe that there is a like tendency to fixity in the sense organs and in the muscles which mark the termini of our reflex arcs. We know that a muscle used in lifting, for instance, becomes adjusted to that work; specialized, in a degree. The sense organs, again, are tuned to pick up certain combinations of stimuli, and not others, as differences in individual performance abundantly testify. But, in the main, we must look to the nervous system for the explanation of habit.

Physiologists have referred habit principally to the *synapses* of the nervous system. A synapse, we have learned, is a point of junction between the end-brush of the axon of one neuron, and the dendrite of another. Nerve-currents are regularly sent *into* neurons through their dendrites and out along their axons. The neuron acts as a one-way valve, maintaining the flow of nerve-current in one direction. In passing from one neuron to another the nerve current must jump the gap left at the synapses, where the inter-lacing fibers of end-brush and dendrite approach but apparently do not actually touch one another.

The synapse-theory asks us to suppose that the synapses offer, initially, a certain resistance to the passage of a nerve-current. When once a synapse has been traversed, a current will decrease with each successive passage of the current. If the effects of succeeding nervous impressions can thus be retained by the synapses, in the form of a permanently decreased resistance, we have a means of explaining habit-formation.

How Habits Are Formed.—It is through the synapses, governing the passage of current from neuron to neuron, that reflex arcs become established. Our theory, then, presupposes that the synapses of the human brain, at birth, are neutral and unformed, constituting the means whereby the complicated systems of our learned ways of acting are to be established in the course of individual experience. There is a sense in which we make our own nervous systems to order, according to the pattern required by the circumstances in which we are placed. How are these pathways formed?

If we could observe the activity of the nervous system in detail while a habit is being formed, what phenomena might we observe? Our answer must be largely speculative, and yet it is worth the effort. Suppose, for instance, that a man is learning to palm a card, a trick that can be learned by anybody with the will to practice long enough. The beginner is shown how to hold the card between thumb and forefinger, how to move it into position and grasp it with the fingers so that it may be held on the back of the hand. We observe, in the first place, that the sense organs are focused to the task, the tactual and muscular senses as well as the eyes. From the sense organs strong nerve-currents run towards the brain. If it were possible for us to witness these events we might see the currents coming in over the sensory fibers. They arrive at the association centers, where they spread out along numerous pathways, seeking proper outlets to the motor nerves which carry currents to the muscles of fingers and arms. The currents follow, initially, lines of least resistance. The motions of fingers and arms now produced are such as have been employed in previous acts, although most of them are, in the present situation, unnecessary or ineffectual.

We may assume that all of the muscles involved in the act of card-palming have been produced previously in other combinations. The present task is to achieve the proper coördination of the detailed movements required by the new act. To accomplish this new synapses must be opened across the associative tracts; new "patterns" must be formed. How are the proper synapses opened up? At first the desired connection seems to be hit upon by chance. Under pressure—the result of the inhibition of certain movements observed to be superfluous—the nerve currents are forced through resisting synapses, and thus new possibilities in the way of combination are presented. As the act is repeated again and again we find that certain of the pathways involved come to be used more and more, others less and less. There finally comes a time when the incoming currents are switched immediately over pathways which have become established as lines of low resistance. The incoming currents cease to spread out at random, but flow directly through the well-worn channels. The trick is learned, and can be performed with the uniformity, facility, and independence of attention that is characteristic of established habits.

In this "trial and error" process by which the coördinating nervous pathways are established, selection is, of course, at work. When a correct result is reached, the pathways which produced the effective motions are confirmed. The pathways which give poor results, on the other hand, are abandoned. *The selective activity thus manifested is—in its physiological aspects—conscious effort.* We do not understand its nature. We have no means of knowing how new pathways in learning are chosen, nor can we comprehend the manner in which attentive consciousness intervenes to inhibit or reconstruct habits once formed. Physiology fails us here. We may not, however, be skeptical concerning the psychological facts, since they are evident even to untrained observation. To sum up, then, all that we have said, in a word: habit becomes fixed through the "fixing" of the synapses. Changes in their resistances, once accomplished, are retained as permanent modifications.

Habit in Action.—A habit once established reels itself off automatically, when it is set in motion. Given the proper stimuli, and a situation which offers no counteracting tendencies, the series of movements that constitutes the habit occur in a routine order, each following automatically upon its predecessor.

The habit, however, is not exploded into action once and for all by an initial stimulus. We find, by observing such processes, that the chain of movements is supported and kept going by a stream of afferent nerve currents. These are switched to the proper motor outlets by a series of associative adjustments. James represents the process as follows:

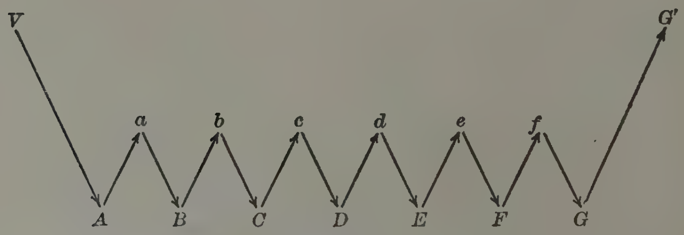

Fig. 9.

"In habitual action," says James, "the only impulse which the centers of idea or perception need send down is the initial impulse, the command to *start*. This is represented in the diagram by *V;* it may be a thought of the first movement or of the last result, or a mere perception of some of the habitual conditions of the chain, the presence, e.g., of the keyboard near the hand. In the present case, no sooner has the conscious thought or volition instigated movement *A,* than *A,* through the sensation of *a* of its own occurrence, awakens *B* reflexly; *B* then excites *C* through *b,* and so on till the chain is ended, when the intellect generally takes cognizance of the final result." It is this direct linkage of sensory and motor, over pathways that demand no conscious supervision, that makes possible the kind of activity that we call habitual or "secondarily automatic."

We must not exaggerate, however, the uniformity or independence of habitual conduct. Lacing the shoes is a habit, but one seldom performs the act twice under approximately identical conditions. The hands will be found in different positions, according to the posture assumed; the shoes and laces will require some variation in treatment on each occasion. Movements of varying strength and complexity will be called for and in a varying order. A man-made shoe-lacer would perform its acts in precisely the same way on each occasion, down to the smallest detail. Our habits are not fixed in the same degree. They must be variable, must be fairly plastic, if they are to be really serviceable.

Our Dependence on Habit.—The greater part of our conduct is habitual in the sense that it depends upon learned modes of response. Whether we walk, or talk, or play or work, our movements are controlled through sensori-motor arcs established in the nervous system by trial and practice. The simplest gesture of the hand will involve many muscles whose movements must be appropriately coördinated. The gesture, that is, depends physiologically upon a neural mechanism formed by practice. This is true of all acts, simple or complex, which manifest mentality.

Without habit, thus considered, we would be helpless. Were it necessary for us to govern every particular muscular movement by attentive effort we would starve to death in the presence of our food. But eating dinner is, on most occasions, an activity that actually involves little attentive effort. Given the table-situation, with its familiar stimuli backed by an appetite, the business of eating progresses with automatic precision, as he discovers who sugars his coffee twice. Attention wanders to the process only now and then. We concern ourselves with the conversation that is going on, or revel with Epicurean delight in the smack of the food. The actual activity of eating goes forward upon the smooth skids of habit, leaving attention free to play upon matters of greater interest or moment.

It is a curious fact, not without paradoxical implications, that our attentive consciousness can be free only to the extent that we are supplied with effective habits to carry on the routine business of life. Freedom depends upon mechanization. The individual who would be a wit at the dinner table must be free to put this attention upon the passing conversation, but he cannot do this unless his table manner is so habituated as to function smoothly without conscious guidance. The novice who confronts a polite array of silver and strange viands cannot, however great his native intelligence, avoid technical errors, and at the same time carry on a brilliant conversation. This is true of every active situation in life, whether we be called upon to deal with people or with objects.

Habit and Attention.—We find, accordingly, that attentive consciousness intervenes where habit fails us, and in this circumstance we discover the basic significance of consciousness. All habits, we have said, are learned, and learning presupposes attentive effort. Now any process of habit-formation is initiated with reference to a situation in which some form of response, not previously employed, is demanded. By attentive effort, involving trial and error, we learn to make the response required. If the response so established be repeated again and again it becomes confirmed as a habit. And thus each individual has, by forming new modes of response as these were required, accumulated a great fund of habitual responses which enable him to adjust himself fluently to familiar situations.

Even the most routine human life, however, is fraught with unexpected circumstances and events. In the case of an active person, dynamic with plans and ambitions, the unexpected is forever turning up. Habit remains perpetually inadequate, for this reason, and must be perpetually supplemented by the constructive effort of consciousness. Although we are forever dependent upon habits, there is another sense in which we cannot depend upon them at all. We cannot, that is, in any active situation, leave *all* to our habits. They demand constant supervision.

Consider what occurs when an artist plays a complicated composition for the piano at sight. Habit is here, in abundance. Without long and arduous practice such a performance would be impossible. But we must not overlook the fact that many of the combinations of notes now struck are new; new coördinations of the musculature of arms and hands are being formed—actually formed—as the playing proceeds. Although the activity is grounded in habit attention nevertheless plays over the activity as a whole, ready to supplement habit at any point of weakness. The movement of attention is rapier-like in its quickness and precision. It moves ahead of the playing, anticipating and constructing, opening the way for novel responses to which habit alone is not adequate. We are accustomed to think of attention as involving fixity and sustained concentration; but these lighter and quicker movements of attention are not less real or effective than our most ponderous reflection. Conscious activity, here appearing as the governor of habit and builder of new coördinations, is found to be intensely dynamic, incessantly active, a factor in every intelligent human response. We shall discuss attention at greater length in a later chapter. For the present it may suffice to observe that habit, taken alone, is never adequate to sustain intelligent behavior, however essential it may be in the way of providing the materials out of which intelligent response is constructed.

Habit Not Purely Mechanical.—But having said so much, we find ourselves compelled to guard against the error of taking too literally the notion of attention "intervening" in the case of the failure of habit. We should thereby ascribe to habit a purely mechanical character which it does not possess, and to attentive consciousness a separateness of existence and function which would ultimately prove unintelligible. M. Ravaisson, a distinguished French writer on habit, contends that "The law of habit can only be explained by the development of a spontaneous activity, which is at once and equally different from mechanical necessity and conscious freedom." And this embodies the same thought that was in Aristotle's mind when he observed that habit, considered as a form of behavior, is not to be found in the inorganic world.

We can perhaps best understand what is meant by observing the analogy between *instinct* and habit. When we contrast the activity of an instinctive creature with the voluntary activity of man the instinctive performance seems utterly mechanical and routine. We ourselves, in an earlier chapter, have used such terms in describing the operation of instinct. But, even so, instinctive activity is not absolutely stereotyped. It is not mechanical in the sense of being invariable, like the movements of an automatic machine. Instinctive activity never occurs under identically similar conditions. It must be somewhat plastic, modifiable to suit varying circumstances. It is not mechanical, in a word, but psychical, showing an inner urge towards ends and a tendency to vary the means to their attainment. The responses of the instinctive creature are, we have said, specific in character, and limited in number. It is this limited and specific adaptation of the instinctive being, together with its slight capacity for forming novel adjustments, that gives its reactions their stereotyped appearance.

There is a considerable parallel between instinct, so regarded, and human habit. Habit is never invariable, it takes the form of specific modes of response to familiar situation, it expresses a psychical propensity towards certain ends. Were a man to be suddenly bereft of all his capacity to learn, were attentive consciousness to be paralyzed (could this be done without entire mental dissociation), and nothing but habit left, it would in all probability operate much in man as does instinct in the lower creature. In the familiar and routine situation and act the individual would be effective. But, the thing is inconceivable. The thought may serve to suggest to us, however, that habit is mechanical after the fashion of instinct, and not according to the pattern of the machine or the repetitive inorganic process. Habit, in man, like instinct in the ant, expresses a psychical and not a purely physical nature.

Automatic Writing.—These remarks may be reinforced, in passing, by reference to the peculiar phenomena of automatic writing. In this form of motor automatism the writing is performed without the assistance of the conscious will of the operator, or even in spite of it. The hand writes, it seems, by itself, guided by the "subconscious" personality—or by the lower automatic centers of the nervous system. Automatism of this form is too well authenticated to require justification for the statement that it occurs in independence of conscious control.

The sub-liminal or sub-conscious personality which is, by whatever means, made temporarily free from volitional control, is commonly believed to be a "secondary self" having its ground in certain neural complexes in the associative centers of the nervous system. The movements of the hands are governed by the same sensori-motor pathways which are employed in normal writing. The "thought" expressing itself is supposed to come from the same associative complexes whence reveries and dreams emerge. The process of automatic writing, in a word, is represented as a running-loose of some portion of the individual's neural habit-system.

If this is true—and, in the main, it must represent a considerable degree of truth—then we must attribute to our automatic activities a degree of spontaneity altogether incompatible with a strictly mechanical conception of the nervous system. The sub-conscious reveals a psychical character, a coherence and purposiveness, which are foreign to mechanical automatism.

The Conditioned Reflex.—Certain physiological experiments, most notably that of Pavlow on the salivary reflex, have greatly influenced recent discussions of habit-formation. The following quotation, from Smith and Guthrie's *General Psychology*, is typical:

"How may a response be provoked by a new stimulus? Let us take the case of a dog that sees a cat. On seeing the cat he barks. Suppose that while looking at the cat he hears his master say the word 'cats' and that these two stimuli occur together several times. Later if he hears the word 'cats,' although there is no cat present, he will bark. This response first called forth by the sight of a cat is now provoked by a new stimulus, namely, the sound of a word. When a response is elicited by a new stimulus, because of the fact that the new stimulus has occurred along with the old, it is called a *conditioned response.*

"If a percussion hammer falls upon the patellar tendon, a spinal reflex is elicited involving the contraction of the quadriceps muscles. This is called the knee-jerk. In 1902, Twitmyer demonstrated that if a bell was sounded each time the hammer fell on the patellar tendon it was possible, after considerable practice had occurred, to elicit the knee-jerk by the auditory stimulus alone. Today a reflex response to a substituted stimulus is called a conditioned reflex, because the substituted stimulus is one of the conditions accompanying the original stimulus. Pavlow discovered that a conditioned reflex could be secured from dogs. . . . Watson and Lashley demonstrated the conditioned salivary reflex in man as well as other conditioned reflexes in both dogs and human beings."

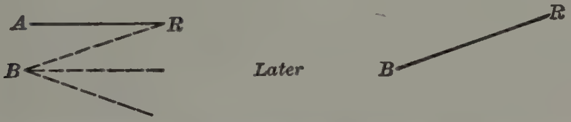

FIG. 10.—Attachment of the substitute stimulus in the case of the conditioned reflex.

No new principle of explanation is adduced from these experiments. Their value consists in an added confirmation of the reflex-arc theory as a physiological principle of explanation and in the demonstration of the continuity between the lower animals and man as well as between lower and higher processes in man.

Learning in Animals.—The general psychologist will perhaps be even more interested in a long series of experiments in the field of animal psychology conducted in the past few years by investigators of high ability. The gist of these findings, as expressed by Professor Warren, in his *Elements of Human Psychology,* is as follows:

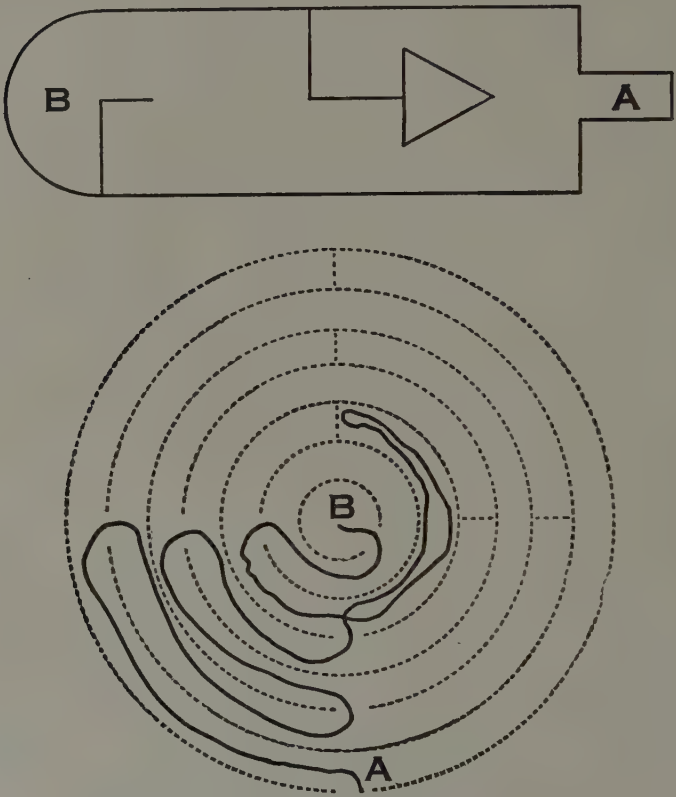

FIG. 11.—Mazes for investigating habit formation

Two mazes used to determine the rate at which an animal learns the right path from A to B. Upper figure is a simple maze used by Yerkes with frogs. One choice of paths at start, one choice near end. [From *Harvard Psychological Studies.*]

Lower figure is a maze used by Hubbert with rats. Heavy line shows actual path of one rat on sixty-second trial. [From *Journal of Animal Behavior.*]

"Although instinct is the usual form of behavior in sub-human species, there is a certain amount of intelligent adaptation in all animals except those low down in the scale of life. This is shown by experiments with the maze. An animal is released at the entrance (A) of the maze, food having been placed at the far end or center (B). The hunger stimulus, reinforced by the odor stimulus, arouses him to action. He starts off and after a certain number of hesitations, false moves, and retracings reaches the food and satisfies his hunger. The same program is repeated on the same or successive days. It is found that after a number of trials the animal succeeds in reaching the food-box in a *shorter time,* and with *fewer false moves,* as indicated by the total distance traversed. In an experiment with 27 white rats the average time was reduced from 467 seconds in the first trial to 40.3 in the eleventh, and the average distance from 4216.1 to 1029.8 centimeters. Even in species as low as the cray-fish and other crustacea there is a slight reduction in time and distance after many trials in a simple maze."

Swift's experiments in learning telegraphy show a similar process of trial and error, with many initial mistakes, but an increasing accuracy and speed with practice.

In forming new modes of response the human being, like the lower animal, makes many false moves in the beginning. But gradually, by a process of trial and elimination, the most effective response-combinations are selected and confirmed as habits.

Plateaus of Learning.—It is found that in the course of the formation of motor habits (as in all learning) progress is not uniform. For a while speed or accuracy increase regularly, in a rising curve. Presently there arrives a period when there is little or no daily progress; there may be even a slight falling back. These static periods, when represented in such learning curves as that shown below, are called *plateaus.*

The significance of the plateau has been much debated.

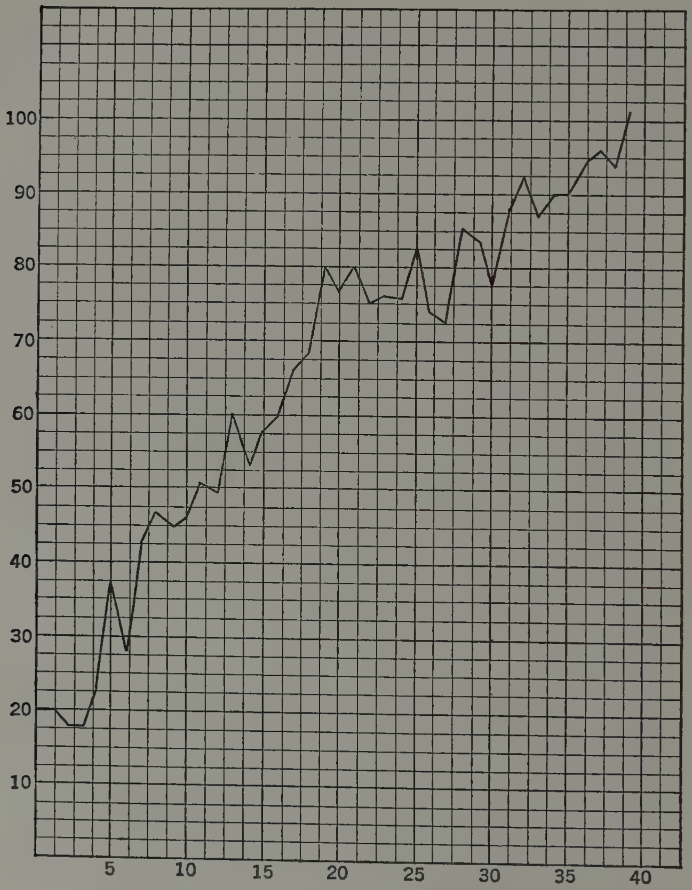

FIG. 12.—Curve of learning.

Shows the progress of facilitation (speed) during the fixing of a habit: learning to telegraph. Vertical numbers denote the number of words which the learner was able to telegraph in 5 minutes after 30 minutes of practice. Horizontal numbers denote successive days. The experimenter was entirely unfamiliar with the habit at the start. [From Swift, *Psychological Bulletin.*]

It is, no doubt, connected with the process of integration going forward in the course of the learning. Such muscular activities as are essential to the performance must be

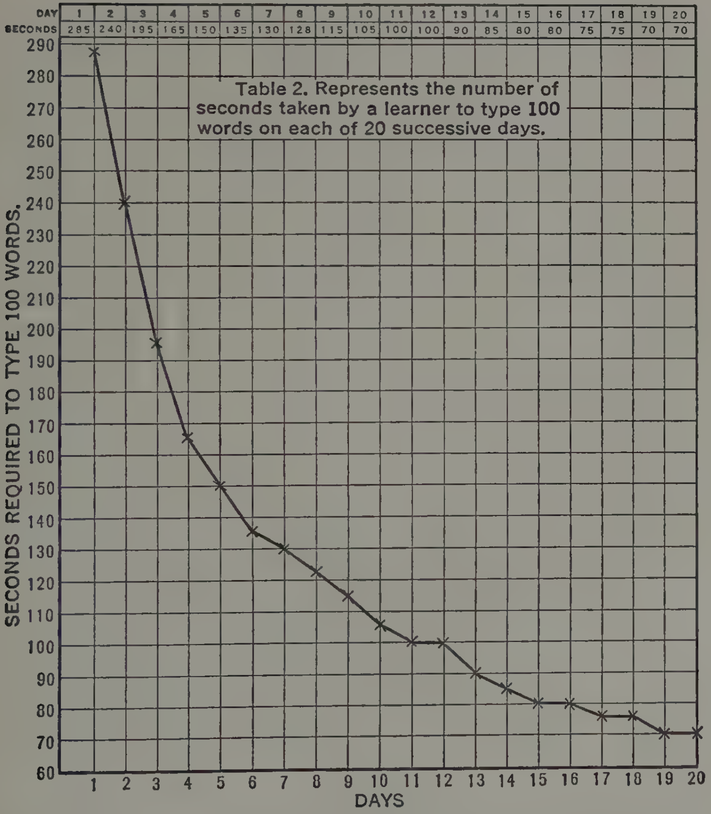

FIG. 13.—Learning of curve for typewriting. (After Foster.)

selected, confirmed and organized before the habit is established. The organization of the response, in neural terms, is from lower to higher, from simple to more complex.

Plateaus occur where some more general, inclusive, complex coördination must be formed before there can be a further advance. Once this is effected, learning goes on as before.

CHAPTER V

SENSATION

> "The division of our external senses into five common classes is ridiculously imperfect. Some sensations, such as hunger and thirst, weariness and sickness, can be reduced to none of them; or if they are reduced to feelings, they are perceptions as different from the other ideas of touch, such as cold, heat, hardness, softness, as the ideas of taste or smell. Others have hinted at an external sense different from all of these."—HUTCHESON.

In a preceding chapter we have described the main lines of communication whereby nervous energy is conducted hither and thither within the human organism as through a switchboard of almost infinite intricacy. This energy occasions the contraction of muscles when it has been conducted outward over the efferent nerve fibers from the central nervous system to the end-plates amongst the muscle fibers. It occasions our sensations, perceptions, and the like when it has passed over afferent fibers to the cerebral cortex and when the cortex has responded in an answering activity more or less simple or complex.

It is our purpose, in this chapter, to attempt an account of the sensory processes and of the organs through which they are mediated. The sensory process is one of extreme simplicity. Titchener has described it as the "simplest thing in the way of consciousness." The strictness of this definition is never maintained in every day speech and rarely even in psychological texts. As soon as an individual has gained but a little experience with his surroundings he begins to interpret the impressions that his environment affords: that is, he begins to *perceive*. From that time on the simple sensory processes that we call sensations become so wrapped up and hidden from view that even the most skilled introspectionist can hardly, if at all, distinguish them; and even if he could make the distinction for himself he could not follow it with an adequate description for the benefit of others. The consequence is that the concept of sensory process in its simplest relation as "sensation" amounts practically to an abstraction that is entertained by a few extreme specialists at most and that carries no *discovered* connection with mental function in relation to human behavior in the broadest sense of that term.

Some Everyday Conceptions.—The terms "sensation" and its close neighbors are variously used in everyday speech. We say "I had a queer *sensation* when I entered the wizard's room" and we are then applying the term to a vague complex of fear and of dread and to perceptions of strange objects. "I *sensed* the atmosphere of the school immediately upon passing the door." The student of psychology interprets this phrase as meaning that the speaker had caught in a moment certain signs that he may have heard or seen, or both heard and seen from which he inferred immediately that the school was doing well or illy. "I *sensed* the meaning of the argument as soon as the senator arose to reply to the attack." In this statement it is clearly implied that the speaker had held on to what the attacker had said and that when the reply had been launched he caught an insight into the situation: that is, he had by this time so far analyzed the case and reflected upon it that he knew its meaning. Once more we say: "I had a *sensation* of warmth when I was no less than a half mile from the blaze, but I had no knowledge or suspicion of what was going on.'' In this phrase we come closest to the technical meaning of the term sensation. It is a mere awareness of ''something there.'' My finger is now resting upon a thing that was not there a moment ago. What it is, whether wood or stone, has not yet entered my consciousness. An impression has reached my eye; whether it is of red or yellow, I know not, but it was not there a moment ago. I have not even begun to interpret it. It is merely an awareness of ''something there,'' that is different from what was there a moment earlier, and no more. It is ''sensation,'' and the ''sensory process'' includes all physiological goings on that are functionally related to the awareness.

It is now clear why we said above that the processes we are discussing here are in the main abstract concepts that exist only in the mind of the specialist. It is, nevertheless, of great interest and importance for the student to make a survey of the capacities of the human organism to register or to become aware of differences in the sense of ''having'' mere sensory processes. It should be quite obvious that our capacities for such awareness lie at the bottom of whatever other *capacities* or *functions* we may develop for *naming* things, for *making analyses*, for *talking* and *writing* about them and finally for making other fine adjustments to the most complicated situation: to the Herzian waves, for example, or perhaps to an international economic congress for the purpose of discovering the most fundamental economic clashes amongst the mountain of subordinate clashes in order to bring about a reconciliation and to develop a system of friendly coöperation. In other words it is just in this capacity to be aware of differences that we find, in the last analysis, the root of whatever degree of possibility there may be, for developing our civilization to higher levels and even for maintaining it at its present height.

Attributes of Sensation.—We have said above that by sensation we understand the mere awareness of differences. These awarenesses differ from one another, in each case, at several points. Certain of the features in which they differ we call their attributes, and when we speak of an attribute we refer to a characteristic which, if it could be taken away, would, by the deprivation, destroy the sensation.

The attributes that are most commonly agreed upon are *quality* and *intensity*. The quality of a visual sensation necessarily differs from that of an auditory sensation, and the quality *redness* just as inevitably differs from that of *yellowness*. Take away the quality and the sensation ceases to exist. Every sensation, too, to be a sensation, must have a degree of intensity about it. Quality and intensity are undoubtedly attributes. The former is generally acknowledged to be contributed by the nature of the sense organ and the latter by the strength of the stimulus. There are exceptions, however; a thermal stimulus of a certain degree, for example, occasions a visual sensation of redness. A stimulus of the same character but of very much greater strength occasions a sensation of whiteness. Thus we speak of "red heat" and of "white heat": two different *qualities* as well as intensities of sensation occasioned by stimuli of the same character, differing only in strength. Many analogous situations could be described.

Extent and duration are often described, also, as attributes of sensation: as much as to say that sensations have both spatial and temporal characteristics that are indispensable to them. It is more probable, however, that as soon as a sensation seems to have one of these so-called attributes we have begun to elaborate upon it more or less and to attach to it an interpretation. In other words we are then no longer dealing with a *pure* sensation. What we have before us then is probably a perception, the like of which we shall, for the sake of convenience, treat separately.

With respect to qualities alone sensations fall into a series; colors, for instance, form a series of unbroken hues, and tones a series of pitches. But tone never passes over into color or *vice versa*. Throughout the series of tones and of color respectively is a series of graduated intensities from what is just noticeable—next to zero—to the maximum.

Sense Organ and Stimulus.— The sense organ is a portion of the central nervous system, highly specialized in respect to its function—and its function is to release an afferent, or sensory nervous impulse, when an appropriate or adequate stimulus impinges upon it. The sense organs in man represent a very high degree of differentiation as compared with those of the lowest animals. This differentiation, it is assumed on good ground, has gone hand in hand with the development of capacities for adjustment in the course of animal history. We have shown in the chapter on the Evolution of Mind that the amoeba, for instance, is altogether undifferentiated in respect to sense organs. It reacts when *any* point upon its body surface is stimulated by the energy of light (even of colored lights) or by another stimulus of whatever character. As we examine one form of animal life after another, passing upward in the scale of complexity of structure, we discover a gradually emerging specialized grouping of nerve-endings that are sensitive to light and to nothing else in ordinary circumstances. Further differentiation occurs within this arrangement and ultimately we have an organ in the most highly developed animal that is capable of distinguishing not only light from other forms of energy but several forms or colors of light as well. Here and there the progress of differentiation has halted and we have—in the field of visual sensation—color blindness, which will be discussed in the proper place. It is possible, too, that the alleged capacity of many totally blind persons to distinguish a lighted from a dark room may signify a certain residue of primitive undifferentiated sensitivity of the body surface to light.

A group of nerve endings, then, so highly differentiated that it can be stimulated by a specific form of energy, and by it alone, is the essential features of a sense organ. There are accessory characteristics, also, of greater or less variety. In the eye, for instance, there are the pupil, lens, and muscles to provide adjustment.

A stimulus is any specific form of energy that, when it impinges upon the essential elements in a sense organ, occasions the release of nervous energy in the afferent or sensory tract. The energy of light is the stimulus in the field of vision; the energy of atmospheric vibration is the stimulus in relation to hearing, and chemical energy released in certain solutions is the stimulus to taste when these solutions come into contact with so-called taste buds, or taste-sense organs in the tongue.

Normally the release of nervous energy in a sense organ can be occasioned only by what is termed the *adequate* stimulus. Light is so described in relation to the eye and atmospheric vibration in relation to the ear. One may sing without end into the eyes of a friend but he will never, by seeing, distinguish the singer's voice; and beautiful pictures before his ears arouse none of the thrill that comes from tones in harmony.

There are certain exceptions, however, to the doctrine of adequate stimuli. A needle-prick upon the retina or optic nerve or a sudden blow upon any solid part of the body will occasion a flash of light as certainly as will the energy of light upon the retina; and irritation to the auditory nerve or contact between the bony frame and a vibrating solid will occasion the sensation of sound.

We will now undertake a sketchy description of the sense organs in turn, beginning with the eye.

THE ORGAN OF VISION

General Characteristics.—The eye is a physiological camera. Its sensitive plate is the retina, and this, in the last analysis, is its essential feature. It contains the sensitive endings of the fibers of the optic nerve. All other parts of the eye serve to protect this essential thing and to facilitate the most advantageous passage of rays of light reflected from an external object to the retinal surface.

The Eye Wall.—The wall or box enclosing this camera is in three layers: the outside is the *sclerotic* of tough connective tissue which gives the box its nearly spherical shape with a diameter of slightly less than one inch. Upon the inner surface of the sclerotic tissue is the *choroid* or colored layer. It is made up of blood vessels, muscles and nerve fibers. The retina, which has already been referred to as the essential feature of the organ, lies upon the inner posterior surface of the choroid. It covers approximately two-thirds of the colored layer.

The cut below shows these walls in median section, front to back, and other details in addition.

The sclerotic coat is modified in front where it bulges outward to form the watch-crystal-like transparent cornea. Behind the cornea is a chamber filled with the *aqueous* humor.

Directly behind this chamber is the *iris*: a very delicate flat muscle tissue, attached to the wall of the eyeball. The iris is the colored portion that one sees in the eye of one's neighbor and at its center is a circular opening, the *pupil,* through which light is admitted into the eye.

The iris is the *shutter of the camera.* It operates automatically to govern the amount of light that may enter through the pupil. The pupil is relatively large in the dark and small in the light. Its alterations in diameter are adjustments that protest against over-intense stimula-

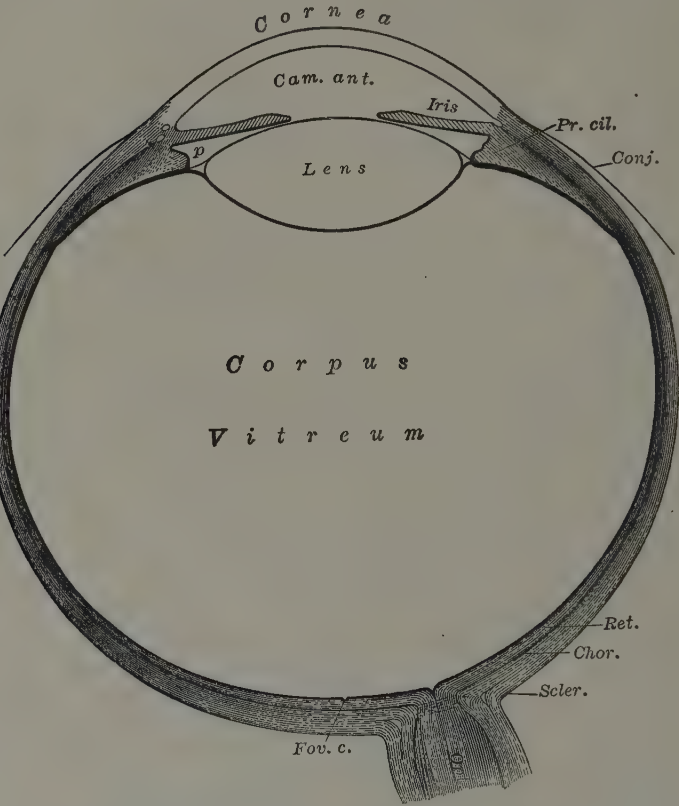

FIG. 14.—Cross-section of the human eye.

Scler., sclerotic coat; *Chor.*, choroid; *Ret.*, retina; *Opt.*, optic nerve; *Fov. c.*, fovea; *Pr. cil.*, the ciliary muscle or ciliary process; *Conj.*, conjunctiva; *Cam. ant.*, the anterior chamber; *Corpus vitreum*, the vitreous humor that fills the posterior chamber.

tion and at the same time assist in obtaining definition of outline in the image upon the sensitive plate—the retina.

The automatic adjustment we have referred to is effected by means of the contraction or relaxation of two sets of muscles: one with radial fibers that dilates the pupil, the other with circular fibers that, on contraction, constricts it. The stimulation of the optic nerve is the first step that sets in motion this machinery of dilation and constriction. The nerve pathways that are involved in the process ramify widely in the central and sympathetic systems so that the degree of promptness of the pupilary reaction to conditions of light and shade is of great importance for the diagnosis of some nervous diseases.

The Lens.—Behind the pupil and the iris or shutter of the camera is the *lens.* By the adjustment of this apparatus rays of light reflected from an object, and passing through, are brought to a focus upon the sensitive plate or retina. Obviously from every point upon the surface of a tree one is attempting to photograph, rays of light are being reflected in any number of directions. The number of rays that are passing—no two of them in the same direction—through the aperture in the shutter of the camera is altogether beyond conception. If these rays, radiating from a given point upon the object, impinge upon the sensitive plate, no two at the same point, there will be no photograph. Here is where the lens of our physiological camera does its work. It bends the diverging rays just sufficiently to bring together at one point upon the retina all rays that have been reflected through the pupil from a given point upon the object of vision. This process is described by the word *focusing.* A perfect focusing in the camera will depend upon the curvature of the lens surface and upon the distance between the lens and the sensitive plate. This space must be varied by the operator to accommodate to the distance of the object from the camera.

There are no *thumb-screws* in the eye by which one can adjust the distance from the lens to the retina. Perfect focusing is obtained wholly by an automatic adjustment of the curvature of the lens. The figure below represents the lens adjustment, on the one side, to objects near by, and on the other, to objects far away. In the former case it is sharply convex, in the latter it is more nearly flat on the front surface.

The adjustment that is illustrated in this manner is brought about by the contraction of the *ciliary muscle* and by its acting upon the *suspensory ligament*. The latter is analogous to a broad rubber band stretched around the circular edge of a watch crystal and in such manner that the greater portion of its width falls over upon the front surface of the crystal. The fibers of the ciliary muscle are set radially like the spokes of a wheel.

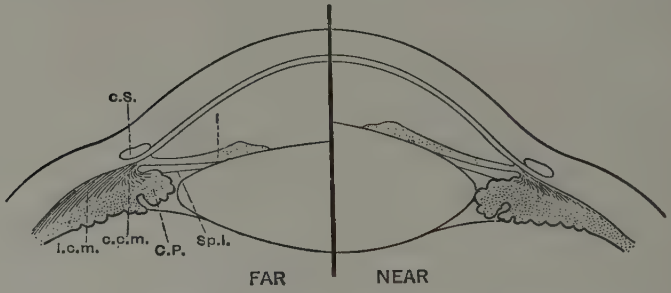

FIG. 15.—Change in lens and ciliary muscle in accomodation. (After Foster.)

The outer ends of these fibers have their attachment in the sclerotic coat near the corneal ridge, and the inner ends are attached to the front edge of the suspensory ligament (the forward edge of the rubber band in the "watch-crystal" illustration used above). It will be clear, therefore, that as the fibers of the ciliary muscle contract, the suspensory ligament will be lifted from the outer portion of the surface of the lens. Inasmuch as the lens is elastic it bulges out when the pressure of the ligament is removed; it is then so adjusted that all rays of light reflected through it from a point upon the object of vision are focused clearly upon the retina. Such rays will be widely diverging and they must, therefore, be rather sharply bent; an end that is attained by the lens in its convex form. When, on the other hand, the ciliary fibers relax, the ligament resumes its former position and exerts once more its pressure against the outer portion of the anterior surface of the lens. The lens is then flattened and is so adjusted that it can bring to a focus upon the retina the rays reflected through it from an object far away. Incidentally the sense of strain and of relaxation, respectively, that accompany near and far fixation of the eyes are, at any rate in part, occasioned by the contraction and relaxation of the ciliary muscle.

Between the extremes of adjustment for short and long distances is an infinite number of possibilities of adaptation to spaces of intermediate extents. All such adjustments are automatic and are probably occasioned by scattering, as opposed to focused, stimuli impinging upon the retina.

The Retina.—Behind the lens is the *vitreous humor* which occupies the greater part of the volume of the eyeball and beyond it the retina which, we have already said, is the essential structure in the visual organ. It may be described as the lining of the posterior two-thirds of the wall of the eye, or as the frayed-out end of the optic nerve. If one were to insert a rope through the wall of a ball, separate the fibers of the rope-end one from another and spread them out thinly over the inner surface of the ball, one would have a crude model of the optic nerve and the retina in their relation to the eyeball.

The retinal tissue is in three layers. Inside (i.e., toward the center of the eyeball adjacent to the vitreous humor) is a layer of ganglion cells and nerve fibers; next to this is a layer of bi-polar cells, and in the third place, adjacent to the choroid section in the wall of the eyeball, are the *rods* and *cones*. These are the sensitive elements. They are anatomically connected through neurites and dendrites with the other cell layers of the retina and throughout there are mingled cell bodies of non-nervous tissue, that serve to support the nerve elements. In addition to other tissues blood vessels abound in the retina.

It will be clear, then, that a ray of light, to reach the sensitive retinal elements, must penetrate through a considerable network of structures as through a brush-heap. In saying so, however, one must except the *fovea* or *spot of clearest vision*. This is a small area near the center of each retina from which the whole insensitive network we have referred to has been, as it were, pulled aside. Upon this spot, therefore, a light-stimulus is maximally effective. When we are interested in making a visual examination of an object the eyes are automatically turned in their sockets in such a manner as to admit the light reflected from the object to the fovea. Around the center of the fovea only *cones* are to be found; outside of it are both rods and cones. On examination of the retinal surface outside the fovea one finds, proceeding toward the periphery, that the cones become less and less numerous in proportion to the rods until, before the circumference has been reached, the cones have entirely disappeared and only rods are to be found.

The Blind Spot.—About 5 mm. nasal-ward from the fovea in each retina is the spot at which all retinal elements unite to form the optic nerve. Here are neither rods nor cones. It is called the blind spot because when light falls upon it alone there is no vision. Its position can be determined very simply. Place upon a card the letters X and Y, for example, the one an inch and a half or two inches to the right of the other. Then with the right eye alone fixed upon the letter at the left, move the card slowly away from a position close to the face. Presently the letter on the right will disappear (because the light reflected from it is now falling upon the blind spot). Continue moving the card in the same direction and soon the lost letter will re-appear because the reflected light is then falling upon the sensitive retina on the other side of the blind spot. It will be apparent that, by a refinement of this method, one can determine the size and contour of the spot.

Function of the Rods and Cones.—The rods and cones are the organs of vision. Evidence for this is found in the fact that where they are lacking—where the optic nerve enters the eye—there is no vision; and in the additional fact that in suitable circumstances the shadows of blood-vessels and nerve fibers may be seen intervening between the rods and cones and the source of light. But not only is there evidence of this nature. It has been found that the rods in a retina that has been exposed for a long time to the light have a washed-out color; but after having been in the dark for a season they assume a purplish hue.

It is, however, from an analysis of the phenomena of visual sensation, in the main, that we have inferred the physiological functions of the retinal elements, and we will now turn to an examination of the phenomena.

Visual Sensations.—There are four series of visual sensations:

1. The spectral color series from red to violet as in the rainbow. One hue in the series merges into the next, not abruptly, and each of the several hues is regarded as paralleled by a particular frequency of vibration of the luminiferous ether per unit of time, or in other words, by wave length.

2. The acromatic or brightness series ranges from black to white through all intermediate grays and is paralleled

at each point in the series by a particular amplitude or intensity of vibration.

3. The third series is represented in the passage from a complete, or fully saturated red, for example, to black in one direction, and to white in the opposite direction. This sort of alteration in sensory quality is paralleled by a progressive change in the intensity or amplitude of a vibration of a given wave length or frequency. When the alteration is from red to yellow or what-not through the shades toward black, the intensity of the vibration is steadily decreasing until it approximates zero; when it is toward white the intensity uniformly increases while, in each case, the wave length remains constant.

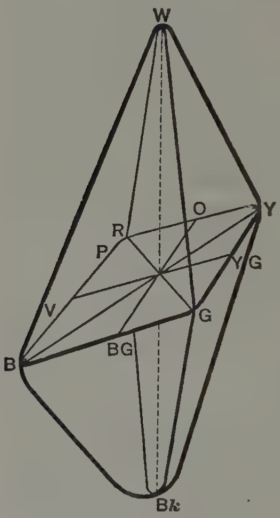

Fig. 16.—Color pyramid.[1]

4. The fourth series is paralleled in any given case, by a mixture of a particular wave-length and intensity. The proportions of the ingredients determine what is called *saturation.* The pure color is fully saturated.

The Color Pyramid. — The figure below schematically represents the relations we have been describing. At the center of the base of the double pyramid is neutral gray, and the area of this base comprises all degrees of saturation—the fourth group of qualities—of each and every color quality that is represented on the perimeter. Along the oblique lines connecting the perimeter of the base with

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[1] Titchener's Textbook of Psychology. Copyright 1910 by The Macmillan Company. Reprinted by permission.

W (white) and with *Bk* (black) are the shades, the third group of qualities. Upon the line joining *W* and *Bk* there are represented all of the second or achromatic series; and upon the perimeter of the base are all pure spectral colors—the first group of visual qualities.

COLOR AND BRIGHTNESS COMBINATIONS

Any possible visual experience of color and of brightness can be induced by appropriate combination of the qualities that are represented schematically in the double pyramid.

To begin with the series of brightnesses between white and black: when the stimuli that occasion these two extremes of brightness respectively are simultaneously applied to the retinae, a middle or neutral gray is produced. Other brightness qualities can be produced by appropriate variation of the component stimuli. The customary method of procedure is to rotate rapidly upon an electric motor, a half black and half white cardboard disc. If two discs are used, one all black and the other all white, each of which is slit from circumference to center, the one can be slipped into the other so as to expose one-half of each and they can then, furthermore, be adjusted so as to expose any desired number of degrees measured upon the circumference of the discs respectively—or, in other words, any desired area of each disc surface. By adjustment and rotation of the combined discs every distinguishable shade of gray can be produced, to the number, certainly, of several hundreds.

Four other qualities, in addition to white and black, combine among themselves and also with any given brightness quality to produce other hundreds of distinguishable sensory experiences.

Psychologically there are the four primary color qualities, red, yellow, green and blue. Each one has its own characteristic brightness: yellow, for instance, is brightest and blue is darkest among the four, and hence in the double color pyramid above the base is tilted with *Y* nearer to *W* and *B* nearer to *Bk.*

Any two adjacent colors represented upon the base of the pyramid may be combined upon the rotator in such manner as to produce those qualities that lie in a series between the two primary colors respectively. Thus red and yellow combine to produce orange; yellow and green, to produce yellowish-green, greenish-yellow and the like, green and blue to produce greenish-blue, bluish-green, and other like qualities, and finally blue and red combine to produce the purples and violets in the series that completes the square. Altogether in these part series of combinations there are upwards of 160 distinguishable color qualities.

But not only may such combinations as these be effected. Those qualities that are approximately opposite to each other upon the base combine with one another, in the same manner, to produce the same neutral gray that is found by combining white and black. Yellow and blue for example, combined, produce gray. Readers who are familiar with mixing pigments are likely to be confused at this point because it is their experience that blue and yellow pigments when mixed produce a green, not a gray. There is, however, no contradiction here. Each component material in this case reflects green light in addition to blue and yellow respectively. The latter combine to produce a gray; in other words they cancel each other and the green remains over. Hence we say that the mixture is green.

It should be explained at this point that not everything that the everyday observer classifies as pure yellow and pure blue or as red and green will combine in this manner to produce a neutral gray. The wave lengths of color qualities determine exactly the combinations which will produce a neutral gray. No simple statement of the facts can be made that can be verified by all observers. Such qualities as do produce gray when combined are called complementary and the following table indicates in parallel columns the wave lengths of such colors as have been described, by two independent observers, as complèmentary.

Table of Complementary Colors for Two Observers *

Observer von Kries		Observer von Frey	
Long Light Wave in $\mu\mu$	Complementary Short Light Wave	Long Light Wave in $\mu\mu$	Complementary Short Light Wave
656.2	492.4	656.2	485.2
626	492.2	626	484.6
612.3	489.6	612.3	483.6
599.5	487.8	599.5	481.8
587.6	484.7	587.6	478.9
579.7	478.7	586.7	478.7
577.6	473.9	577.7	473.9
575.5	469.3	572.8	469.3
572.9	464.8	570.7	464.8
571.1	460.4	569.0	460.4
570.4	440.4	566.3	440.4
570.1	429.5	566.4	429.5

* Pillsbury, Fundamentals of Psychology.

Negative After Images and Contrast.—If one fixes one's eyes for a few seconds upon the bright sun and immediately thereafter upon a whitish wall, a dark gray or black circular area will develop there after a few additional seconds. Everybody has observed this phenomenon. Conversely, if the object fixated is black and the eyes are turned toward a gray wall, a lighter gray will develop upon it. This is the negative after-image in the sphere of brightness sensation. The same order of phenomena occur in relation to sensations of color. If the object fixated is yellow the negative after-image will be blue, and conversely; if it is red, the after-image will be green, and conversely. That is to say, the negative after-image is always complementary to the stimulus. If the after-image is projected upon a colored background the image will combine with the color of the background according to the laws of color mixture. Thus if a green after-image be produced upon a red surface the net result will be a gray.

Analogous to these phenomena are those of contrast. A red brick upon a green sward does not present quite the same appearance, when observed from a distance, as does the same brick when it is built into a wall with others exactly like it. It is redder in the grass than in the wall. If a narrow strip of gray paper be placed across a red surface and the whole be covered closely with tissue paper, the gray band will be seen through the tissue to be tinged with green, and conversely; if the gray, in similar circumstances, is upon yellow, it will appear as bluish and conversely. A section of red paper upon gray will be bounded by a band of light green, a yellow section by blue, and so on. In each of these cases the induced color is a contrast effect, and it will be observed that it is always the complement of the stimulus. If a white light and a red light are admitted into a room so that they will cast two distinct shadows of a rod or post upon a gray surface, one of the shadows—the one occasioned by the red light—will be green. Similar contrast effects are seen in nature. In the summer sunlight, for instance, the gray shadow of a tree upon the green grass is purplish: that is, it is in the neighborhood of red, the complement of the green of the grass. A shadow upon the snow in yellowish sunlight is bluish: blue is the complement of yellow.

All these phenomena of complementaries indicate an association between certain pairs of color qualities and of brightness qualities—an association that implies a substantial basis in the structure and function of retinal elements. But to this we shall return later.

Peripheral Vision.—If one will fix one's eyes upon a spot on the wall directly in the front, the outline and form of the huntsman in a wall-picture about forty-five degrees on the right may still be seen with some distinctness. The red coat on the huntsman's back will not appear as red, however, but as gray. Now if the picture be moved leftward sufficiently and the eyes be held fixed as before, the color of the coat will become apparent. If the coat were green, the phenomenon would be approximately the same.

Individuals differ in matters of this sort but when rigid test conditions are applied it is found that a red or a green surface approaching either eye from the temporal side, must arrive at a point within 20 or 30 degrees of the line of regard (a straight line from the pupil of the eye to the spot of fixation upon the wall) in order that it may be seen as red or as green as the case may be. Before it arrives at this point it is seen as gray. Yellow and blue surfaces can be seen as such only when they have arrived, from the same direction as above, at a point from 70 to 75 degrees from the line of regard. Beyond this limit they, too, are seen as gray. A yellow-green surface approaching in the same manner will be seen first as gray, then as yellow, and finally at 20 to 30 degrees, as yellow *and* green. Analogous phenomena may be observed in relation to orange, green-blue, purple and violet. In fact, whatever be the angle of approach of a surface of primary color, such reaction differences as those we have referred to will be observed.

It is evident, therefore, that there is only a restricted area at the center of each retina that is sensitive to all color stimuli in addition to brightness stimuli. A somewhat larger area responds to all color stimuli. Beyond this region is a peripheral area of color blindness. When it is stimulated, whether by colored or by uncolored light, only gray can be seen.

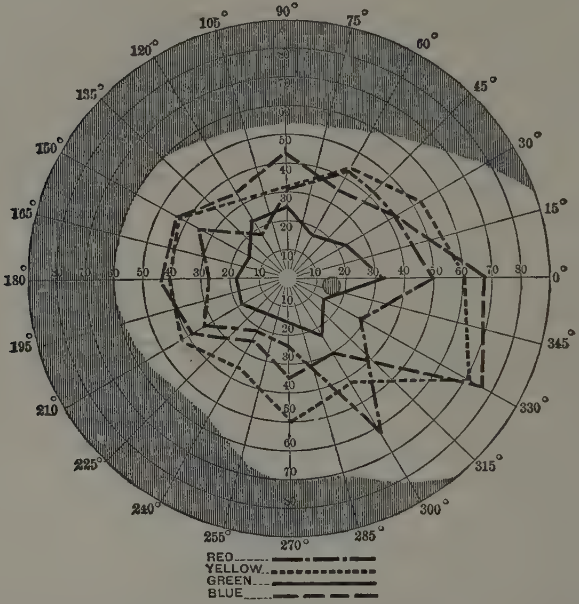


FIG. 17.—Color zones of the retina. Limits at which four colors disappear in passing from center of eye toward periphery, determined for radii 30° apart. Right eye. (After Warren.)

In order to demonstrate the facts as we have stated them here, the color stimuli must be completely saturated, and the colored surfaces that are used as stimuli must be of uniform area. The figure above represents these relations in graphic form.

The boundaries of the retinal areas represented in the above figure are not perfect circles and the two inner circles should be set somewhat to the left or to the right according to whether the figure represents the right or the left retina respectively.

Color Blindness.—The foregoing, like a phenomenon of colored negative after-imagery and of contrast, suggests an intimate association of complementary colors—and at that, an association due to differences within the retinae. The central region in each retina must contain some elements that are not to be found in the peripheral region where everyone is blind to all colors.

A consideration of these phenomena suggests some other infrequent forms of color-blindness. Perhaps three or four per cent of men, and a smaller proportion of women, are blind to red and to green—the *red-green blind.* They distinguish white and black and all intermediate grays represented in the color pyramid and in addition all visual qualities that lie upon the line terminated by yellow and blue passing from *Y* in the pyramid to *B*, cutting at its middle point (neutral gray) the line *W-Bk.* That is, among the colored qualities they see only yellow, dull yellow, dull blue and fully saturated blue. All those qualities that belong to the third, or *R-G* dimension, are seen as more or less unsaturated yellow or blue. Cases of total color blindness are much rarer.

These forms of blindness are probably due to the distribution of rods and cones in the retinae. As we have already seen, at the foveae the cones predominate, but in the peripheral region they are absent. At any rate this condition appears to account for the universal peripheral color blindness. Red-green and total color blindness are due to a lack of cones or to a failure of certain cones to perform their normal function owing to an absence from them of some essential elements. The latter is the more probable inasmuch as at the fovea, which is sensitive to all color and brightness stimuli, only cones are to be found.

As to what these elements may be we can only hypothesize and we shall return to it below in connection with the theories of the phenomena we have discussed.

Color blindness is of some practical importance. Obviously it would be dangerous to employ in railroading and in navigation persons who are unable to see red and green lights. It is a condition that cannot be overcome by training, although the seriousness of the defect may be mitigated thereby. We have occasionally heard of an engineer who was red-green blind but who never ran beyond a danger signal. Assuming the authenticity of the reports, it must be possible for one to *learn* to distinguish a danger signal on the basis of its brightness or lack of brightness.

Theories of Vision.—We have already alluded in general to the analogy between the eye and the photographic camera. The retina is analogous to the sensitive plate in the camera. We are at present interested in what goes on in the sensitive plate, when one *sees* brightness or color.

The rods are supposed to be the organs that function when light energy is low—as in the twilight. The fact that owls, bats and other nocturnal animals have retinae that are deficient in cone structures and richly supplied with rods, is one indication that points to this conclusion. The reader, furthermore, can make a rough test of this point upon himself. If, in the twilight, he will fix his eyes rigidly upon a spot on the wall, he will find that the point of his pencil is less distinctly visible when it is directly in the line of regard than when it is aside from that line, in any direction, but yet within the normal field of vision. It will be recalled that upon the periphery of the retinae the rods are relatively much more numerous than the cones and that at the functional center of the retinae, the foveae, there are no rods.

The phenomena of daylight vision are many and complex as compared with those of twilight and the hypotheses with reference to them are less satisfactory. A theory of daylight vision must account for the phenomena of color mixture, of negative after-imagery, of contrast and of color-blindness—these principally. No theory fully satisfies all the requirements. The one that is most widely known is named for its author, the Hering theory.

Hering assumes that there are three photo-chemical substances in the cones and he calls them the *white-black,* the *red-green* and the *yellow-blue* substances. The first is affected by every light stimulus that exceeds a certain minimum of energy. Each of the other substances is affected only by the particular wave lengths that correspond to red and green and to yellow and blue. The three substances are capable of six distinct reactions: the extremes of brightness and the two pairs of complementary primary colors. The members of these pairs of reactions respectively are described as antagonistic. The combinations of these six reactions or of one or more pairs of them produce all the phenomena of vision. There is an exception to this statement; neutral gray may be produced by combining white and black upon the retinae *and also* by the simple expedient of going into a dark room or by otherwise excluding light from the retinae. In such a case neutral gray appears to be a resultant of cortical activity alone. If yellow and blue light be combined upon the retinae, the stimuli are assumed to affect the yellow-blue substance in equal and opposite ways and to arouse antagonistic reactions which neutralize each other. The white-black substance is stimulated also and antagonistic reactions are induced in it. If both white and black reactions are equally aroused they will cancel and the total result will be a neutral gray. On the other hand, the brightness stimulation may be of such a nature that the black reaction will overcome the white reaction or conversely. In such a case the net result will be a dark gray or a light gray according to the circumstances.

If yellow and green lights are made to stimulate the retinae simultaneously, a reaction-tendency of the yellow-blue substance and a reaction tendency of the red-green substances are aroused. These are not antagonistic as are yellow and blue. The two will not cancel out and block each other to a standstill. They go on together after a fashion and the resultant is green-yellow. But the white-black substance is stimulated at the same time with the result that it is a green-yellow of a certain brightness, depending upon whether the white or the black reaction predominates.

The theory accounts for the negative after-image as follows: if the eyes are directed toward a yellow stimulus the corresponding reaction of the yellow-blue substance occurs, but it gradually reduces. In this respect it is analogous to a phenomenon of fatigue. The reduction of the yellow reacting tendency gives the antagonistic blue an advantage so that if the yellow stimulus be removed the blue tendency asserts itself, and the blue after-image is distinct. If the stimulus in this case is not removed the yellow reaction gradually reduces and the blue reaction tendency increases until at last they approximately balance each other and the stimulus appears only as a very faint yellow or as a gray. At this point complete adaptation or equilibrium has resulted. Just such a course of events as this occurs when we put on yellow glasses, see all objects as yellow and ultimately, when we become adapted, as gray, or in their natural color, whatever it may be.

The phenomena of contrast are accounted for by the theory as follows: it is assumed that over the whole area of the retinae the tendency of the visual substances is to maintain equilibrium. If then the eyes be directed toward a gray strip of paper that lies upon a field of yellow, it is obvious that the yellow reacting tendency is being reduced over a considerable area of the retinae. Therefore, within that retinal area in each eye that is not directly stimulated by yellow light but by gray, the antagonistic reaction tendency has an especially favorable opportunity to assert itself—and the strip of gray is seen as bluish.

The main phenomena of color-blindness are explained by the assumed lack of one or another of the substances—the red-green, for example.

But the theory does not meet all the situations: red and green are not strictly complementary and antagonistic. When they are combined upon the rotator the resultant is not gray but yellow.

The more recent Ladd-Franklin theory apparently does justice to all the facts including the yellow resulting from the combination of red and green. Dr. Ladd-Franklin assumes that the approximately concentric functional areas within the retina correspond to three stages in the evolutionary differentiation of visual elements. The original eye could distinguish only brightnesses; next yellows and blues in addition to brightness and finally the red and green functions became differentiated. The last are consequently the least stable functions and hence red-green blindness is more frequent than other forms.

This conception of primitive and less primitive visual functions is made use of in explaining the phenomena of color mixture. When we try to get a blend of all spectral colors upon the retinae we fail and revert to the most primitive form of response—gray. The same thing occurs when we try to blend yellow and blue. When we attempt a blend of red and green we revert to the just more primitive level of yellow.

THE MECHANISM FOR HEARING

The Auditory Organ.—The auditory organ is composed of three divisions commonly known as the outer, the middle and the inner ears. It is a complicated device that is so constructed as to bring certain aerial vibrations indirectly into touch with the end-organs of the auditory nerve.

The External Ear.—The external ear is composed of the pinna, commonly called the outer ear—and the auditory meatus or tube that terminates at the ear drum or *membrana tympani.* In its general outlines this portion of the organ bears some resemblances to a funnel.

The Drum and the Middle Ear.—The drum is the membranous structure between the external and the middle ear. A delicate muscle, the *tensor tympani,* is attached to its inner surface and to the head of the malleus which is described below. By its contraction and relaxation it automatically maintains the proper tension and relaxation of the drum membrane so that it is protected against extraordinarily intense vibrations and is enabled at the same time to react promptly and accurately to all vibrations within certain extremes.

The Ossicles.—There is attached to the inner surface of the drum membrane also a chain of three small bones—the ossicles of the middle ear. The outermost of these is the *malleus,* the middle is the *incus* and the innermost, the *stapes.* They are so named because of their resemblance in outline to a hammer, an anvil, and a stirrup, respectively.

This system of bones is suspended by a ligament from the roof of the middle ear, and the inner end of the *stapes* is attached to a membrane that covers an oval opening in the inner bony wall of the middle ear. The whole system, therefore, swings with the vibration of the drum membrane occasioned by the vibrating air outside the body and impinging upon it. A small muscle, the *stapedius,* attached to the stirrup and to the middle ear wall, coöperates with the tensor tympani mentioned above in maintaining the entire system in a hair-trigger state so that normally it will respond to very slight impacts of air waves upon the outer surface of the drum. This system steps down somewhat the amplitude of the vibration of the drum membrane. That is, the excursion of the inner end of the *stapes* is less great than that of the drum. The energy of the vibration at the inner end of the system is correspondingly greater than that of the drum membrane.

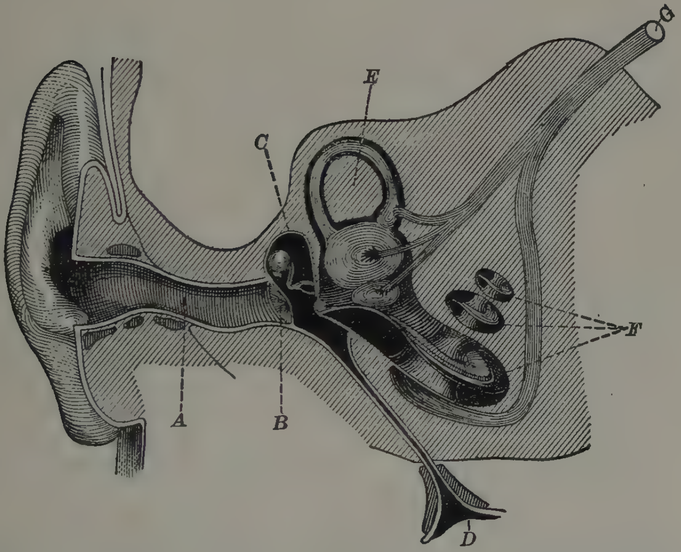


Fig. 18.—Diagram of ear. *A*, auditory meatus; *B*, tympanic membrane; *C*, cavity of middle ear; *D*, Eustachian tube; *E*, semicircular canals; *F*, cochlea; *G*, auditory nerve.

It will be evident that the entire system must be enabled to swing with the very least possible resistance in order that the organ may be most responsive to its stimuli.

The Eustachian Tube.—The freedom of movement to which we have referred is secured, in part, through the agency of the Eustachian Tube which connects the middle ear cavity with the posterior nasal passage. By way of this tube the air-pressure on the inside of the drum membrane is normally maintained equal to that on the outside. Occasionally, in catarrhal conditions, the walls of the tube are congested, the tube is closed and the pressure within the middle ear is greater than that outside of it. The drum and ossicles do not then swing with their normal freedom and as a result hearing is dulled.

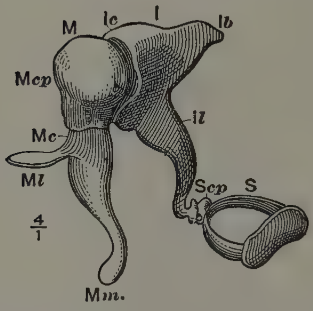


Fig. 19.—The bones of the middle ear. M, hammer; I, anvil; S, stirrup.

The mechanism we have been describing to this point is accessory only to the essential features of the auditory organ. One could hear, after a fashion, without either drum or chain of ossicles. This is demonstrated in the experience of many persons who have suffered the loss of the drum or ossicles or both.

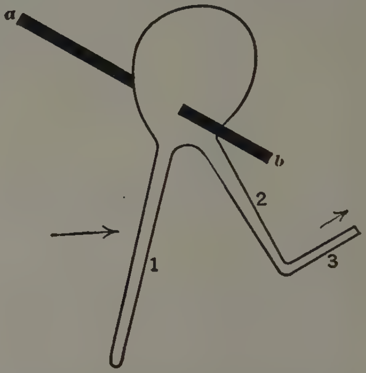


Fig. 20.—How three bones act together as a bent lever. 1, the handle of the hammer; 2, the long process of the anvil; 3, the stirrup; *a-b*, the axis of rotation. (After Howell.)

The Inner Ear.—We are now ready to approach the inner ear, the structure that is essential to hearing. It is protected by a heavy bony wall, and is customarily described as divided into three portions or connecting cavities: the cochlea, the semi-circular canals and, between them, the vestibule. We have no interest at present in the semi-circular canals. They contain organs of the sense of equilibrium and will be described later. These three cavities are filled with a fluid.

The Cochlea.—The cochlea contains the organs of the auditory sense. It is a snail-shell-like formation and is wound two and one-half times around its axis, the *modiolus.* From this axis a bony shelf, the *lamina spiralis,* projects into the cochlear tube and it alone almost divides the tube into two parts from end to end. This division is completed by the *basilar membrane* extending from the edge of the bony shelf to the side of the tube. This shelf, together with the *lamina spiralis,* divides the cochlear tube into two approximately equal portions from end to end. One of these portions, called the *scala vestibuli,* because it connects directly with the vestibule, is separated from the middle ear by the membrane that closes the oval window and to which the stapes is attached as described above. A small triangular section of this *scala vestibuli,* known as the *cochlear canal,* is bounded by the basilar membrane and the delicate membrane of Reissner.

The other half of the cochlear tube, below the bony shelf, is known as the *scala tympani.* It connects with the scala vestibuli around the end of the shelf at the small end of the tube. At its other end it is separated from the middle ear by the round window which is closed by a delicate membrane like that which covers the oval window referred to above. The round window with its yielding covering enables the fluid of the inner ear to vibrate in unison with the atmospheric vibrations.

As the fluid of the inner ear vibrates to and fro through the longitudinal dimension of the cochlear tube in unison with the atmospheric vibrations, these end organs receive their adequate stimulation; the auditory sensory impulse is released and when this impulse arouses its appropriate reaction in the cortical centers we experience the auditory sensation.

SENSATIONS OF HEARING

Auditory Sensations.—Auditory sensations fall into two groups: tones and noises. *Tone.* Sensations of tone are occasioned by periodic atmospheric vibrations. These sensations lie in a single series from low to high. Those of low tone correspond to a slow vibration rate and those of high tone to a rapid rate. The lowest distinguishable tone corresponds to a rate of 12 to 16 vibrations a second and the highest perhaps to 20,000. The uppermost limit is uncertain. It has been variously estimated at from 20,000 to 50,000, depending, it may be, upon the type of instrument that is used in the test. An observer may report differently according as his ear is stimulated by a vibration of greater or of smaller amplitude even though the rate may be the same.

The accuracy of discrimination amongst tones by the trained observer reaches a very high degree, but it differs markedly according to the section of the scale that is being investigated. Tone differences corresponding to 0.3 to 0.2 of a complete vibration can be distinguished in that part of the scale that lies between 64 and 1024 V. D. (complete vibrations) the second. This corresponds roughly to the middle part of the musical scale (40 to 4000 V. D.). At 32 V. D. and 2048 V. D. one must increase or diminish a stimulus by approximately 0.4 V. D. in order that a difference may be noticed. At considerably greater extremes of low and high several vibrations must be added or subtracted before a difference can be observed. It has been estimated that between the lowest and highest extremes mentioned above about 11,000 different tone pitches can be distinguished.

We have said that tonal sensations run on in a series from low to high. This statement admits of a slight modification, however, for at certain points along the way there occur tones that are somewhat similar to one another, called octaves. For the trained ear these points occur at regular intervals and by reason of their similarity, one octave may be mistaken for another just higher or just lower.

Overtones.—A sounding body, a piano string for instance, vibrates as a whole and so occasions what is called the fundamental tone. But the string vibrates also by halves, thirds, quarters, fifths, and theoretically by even the smallest fractional part. The smaller part of the higher the vibration rate. Thus, if a string vibrates as a whole 64 times the second, each half vibrates 128 times, each third 192 times, etc. Corresponding to each of these higher rates is an *overtone.* What one really hears, therefore, when a single string is vibrating, is not a simple tone but a combination of many tones. Several of the components of lower pitch can be distinguished by the trained ear, unaided. Others may be isolated by the help of resonators.

It is largely by the help of the overtones that one is able to distinguish the tones of one instrument from those of another. To them is attributed the so-called timbre of the instrument. But this is not the only criterion in this case: the piano frame and the violin frame respectively vibrate with their strings, and this, too, contributes to the ensemble.

Difference Tones.—If the tones corresponding to 128 and 160 vibrations the second are produced simultaneously the situation is complicated, not only by the addition of overtones to the fundamentals, respectively, but by *difference* tones. There will be a tone, i.e., corresponding to the difference between these rates, 32, another corresponding to twice the lower minus the upper, or 96, and another to three times the lower minus twice the upper, or 64. These tones can not be made to stand out by the aid of resonators. They are, therefore, probably purely subjective. A summation tone in such cases as this can sometimes be heard. It corresponds to the sum of the fundamentals or 288 vibrations.

Beats.—A further result of two tones occurring simultaneously and differing in rate beyond a minimum is the *beat;* alternate moments of strength and weakness of the tone appear. These phenomena are due to the fact that periodically the vibrating bodies that afford the stimuli will be swinging in the same direction and periodically—midway between these phases—in the opposite directions.

Beats will occur when they swing in the same direction. When the swings are in opposite directions, the strength of the tone is relatively diminished. When these alternations appear very close together they appear as roughnesses in the tone. But in any case they occur with a frequency that is represented by the difference between the frequencies of the vibration of two sounding bodies.

Helmholtz Theory of Tonal Hearing.—The Helmholtz theory of tonal hearing has for a long time been in great vogue and it is very attractive because of certain analogies that open the way for plausible argument. We are all acquainted with the fact that if one speaks or sings into the box of one's piano one will, for a moment after, hear certain tones that are occasioned by the vibration of certain piano strings. The strings that are responsible in such instances are those whose vibration rates correspond to those of the singing or speaking voice. It is a case of sympathetic vibration.

The assumption at the basis of the Helmholtz theory is that something of this nature occurs in the ear. The basilar membrane contains something like 10,000 or more cross fibers, no two of exactly the same length, but ranging from about 0.17 mm. to about 0.5 mm. When the fluid of the inner ear vibrates against these fibers at a given rate corresponding to that of the external air those that, because of their length, are capable of the same rate will vibrate with the fluid. Since no two are of the same length there will be but one fiber action in unison with a given vibration rate in the fluid. Several may, however, be going at once, each stimulated by its own appropriate rate of vibration in the fluid. The activity in these fibers, then, is in the last

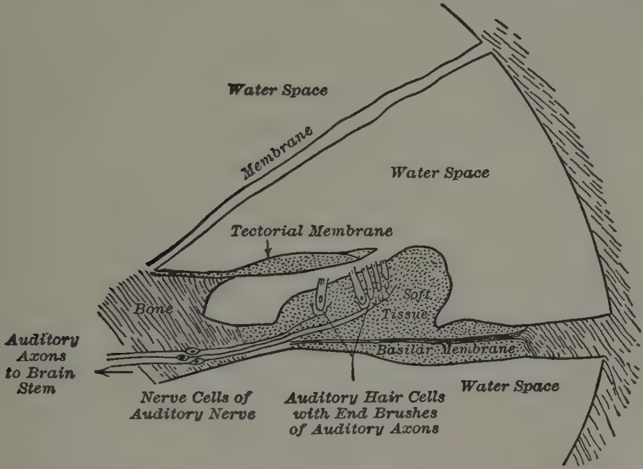

Water Space
Membrane
Water Space
Tectorial Membrane
Soft Tissue
Bone
Auditory Axons to Brain Stem
Basilar Membrane
Water Space
Nerve Cells of Auditory Nerve
Auditory Hair Cells with End Brushes of Auditory Axons

FIG. 21.—The sense cells of the cochlea. The hairs of the sense cells are shaken by the vibration of the water, and pass the impulse back to the end-brushes of the auditory axons. The tectorial membrane looks as if it might act as a damper, but may be concerned, as "accessory apparatus," in the stimulation of the hair cells. The basilar membrane consists in part of fibers extending across between the ledges of bone; these fibers are arranged somewhat after the manner of piano strings, and have suggested the "piano theory" of hearing, to be mentioned later in the chapter. (After Woodworth.)

analysis, the stimulus to the hearing of tones. Each fiber is supposed to stimulate a single nerve terminal that is adapted by means of its ''specific energy'' to the frequency of the fiber. The pattern of the external sound wave is assumed to be repeated in its frequencies, amplitudes and interferences in the movements of the fluid in the cochlea and therefore in the nerve impulses that are aroused in the endings in contact with the basilar fibers. Each impulse is supposed to contribute a characteristic conscious element.

Support for the Helmholtz theory is found in the existence of tonal gaps and islands which are found in certain cases of abnormal hearing. In the progress from low to high tones there are blocks that cannot be heard. These are tonal gaps. Between two such gaps is a tonal island. Their existence can be accounted for by the functional failure of corresponding blocks of cross fibers or by the absence of the fibers.

Telephone Theories.—The telephone theories assume that some structure in the cochlea vibrates as a whole (after the manner of the diaphragm in the ear piece of a telephone) and that the analysis into separate tones is made in the cortex, much as the listener analyzes what is going on in the telephonic apparatus. It has been assumed that the basilar membrane plays the part of the telephonic diaphragm.

Undoubtedly the Helmholtz theory has the advantage because it answers the larger number of questions. But it tugs very hard at the imagination when it asks us to think of the fibers of the basilar membrane as vibrating separately even though they are embedded like threads in a carpet. Furthermore, the extreme difference in length amongst the fibers appears insufficient to account for the maximal difference in tone pitch that can be recognized through the auditory sense.

Noise.—A noise may be described as an incomplete tone or as a tonal vibration that is wholly broken up, so to speak, by cross currents. Thus if two or more series of tonal vibrations, no two of which are harmonious, occur together the result will be a noise. Or if tonal vibrations be cut off before two complete ones have occurred, the result will be a noise—a pop or a snap. The human ear is capable of distinguishing several hundred different noises, perhaps 500 or 600. Add this to perhaps 11,000 distinctions of tone and we have an enormous total of sensory differences of auditory quality that the human organism can isolate.

OTHER SENSATIONS

The Sense of Equilibrium.—When we were examining the ear our attention was drawn to the semicircular canals and sacs, which, it is now known, have no connection with hearing either tones or noises. There are three of these and they occupy, respectively, the three planes of space. Each one terminates in the vestibule of the inner ear, which has already been described, and with it completes an approximate circle. (See Fig. 18.)

The canals, like other portions of the inner ear, are filled with the fluid or endolymph which has already been described. Within the fluid in the sacs, furthermore, are crystals or otoliths. Hair-like nerve endings project through the walls of the canals into the fluid. These endings, like blades of grass growing in a stream of water, will be bent by a current flowing against them. The otoliths in the sacs likewise will be affected by such changes in the endolymph. Interference with the canals occasions the phenomena of dizziness and of deviation from one's course when one is walking from place to place. Thus if the horizontal canal in the left ear be tampered with, the subject of the experiment will deviate, in walking, toward the left; conversely, toward the right. But operative interference is not necessary to demonstrate the main facts. If one whirl rapidly upon one's heel and halt suddenly, one becomes dizzy and liable to fall. In such a case the fluid in the horizontal canals, due to its inertia, lags behind in the whirling movement just as water in a rotating pan would do. When the whirling movement ceases the fluid, again by its inertia, rushes on against the nerve endings and so affords the stimulus that occasions the sense of disequilibration or dizziness.

Nodding the head sharply forward and backward brings the fluid of the median canal into play and a lateral nodding produces the same effect in the transverse canal.

It is probable that the sensory function of the sacs and their otoliths is to afford an awareness of position of the head with reference to gravity, rather than with reference to progression through space.

We have now described above only one of the sources of the sense of dizziness. Apparently eye-movement also is an adequate stimulus. If one stands upon the edge of a bridge some distance above a current of water that is flowing away from the observer, fixates a floating leaf or twig until it has passed some distance away, then jerks the eyes backward to another floating fixation point and repeats the process again and again, one will soon become dizzy. Eye movement, in this case, is the only factor that can produce the result.

In other cases organic disturbances in the alimentary tract appear to occasion the same sensations.

The Cutaneous Senses.—These senses are distinguished by exploring an area of the skin, say the back of the hand, by weak stimuli of various sorts. If, for instance, a bristle is applied lightly to any point on the skin one will obtain the sensation of touch or contact. Here and there with greater intensity of stimulus the sense of pressure arises. At other points, if the bristle is sharp, pain is sensed. If now one employ the point of a lead pencil or a dull steel point of a temperature below that of the skin, one will find at most points only a sensation of pressure or of contact. At other places a distinct sensation of coolness is awakened. All others are indifferent as to temperature. Now if the temperature of the steel point be raised to a level slightly above that of the skin, spots not identical with any of those already located will be found at each of which a distinct sensation of warmth will occur. It is a

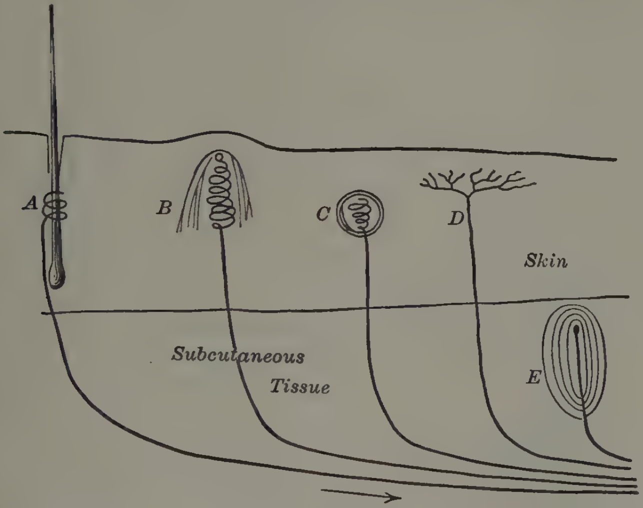


FIG. 22.—Diagram of various sorts of sensory end-organ found in the skin. (After Woodworth.)

A is a hair end-organ; the sensory axons can be seen coiling around the root of the hair; evidently a touch on the hair, outside, would squeeze the coiled axon and stimulate it. The hair is a bit of "accessory apparatus." *B* is a touch corpuscle, consisting of a coiled axon-end surrounded by a little cone of other tissue. *C* is an end-bulb, presumably belonging to the temperature sense. It has, again, a coiled axon-end surrounded by other tissue. The "coils" are really much more finely branched than the diagram shows. *D* is a free-branched nerve end, consisting simply of a branched axon, with no accessory apparatus. It is the pain-sense organ. *E* is a corpuscle of a type found in the subcutaneous tissue, as well as in more interior parts of the body. It contains an axon-end surrounded by a layered capsule.

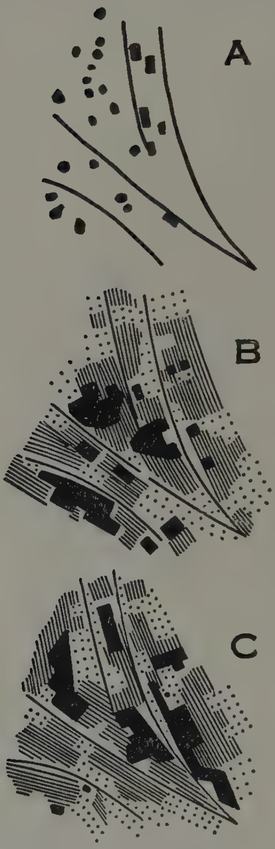


Fig. 23.—Pressure and temperature spots.

Map of palm of left hand, showing relative distribution of sensitivity to pressure (A), warmth (B), and cold (C). Same area is represented in all three cases. In A the regions marked black are relatively *insensitive* to pressure. In B and C the areas *most sensitive* (to warmth and cold respectively) are marked in black, less sensitive in lighter shading, etc. [From Schaefer, after Goldscheider.]

simple matter, by the use of India ink, to mark these several points upon a given area and later to verify their locations respectively.

This alone suggests that a specific end organ may be found in the skin corresponding to each of these senses in turn, and in fact they have probably been pointed out. There are the corpuscles of Pacini, of Meissner, Krause and Merkel. Some are near the surface and others deep in the skin.

Cutaneous Stimuli.—The stimulus for touch pressure and pain is mechanical contact of suitable intensity. The stimuli for the temperature sense are heat waves of high or low degree.

The least observable stimulus for touch, as far as it has been determined by experiment, is probably about 2 mg. on the forehead and tips of the fingers and about 3 mg. on the palms. These figures are for a single contact. If stimuli are rapidly repeated in the course of a second the intensity can be reduced below these levels without obliterating the sensation.

It is a curious fact that if a cool end organ be stimulated by a point whose temperature is far above that of the skin, say 100° F. and more, the organ responds with its normal cold sensation. This is called the "paradoxical cold." It is probable that in this case a hot object excites cool, warm and pain organs simultaneously and that the sense of heat is a blend of cool, warm and pain sensations. If an extremely cold stimulus be applied to the skin a burning sensation arises that cannot be distinguished from that that follows the application of a hot stimulus. This can best—though at great discomfort—be demonstrated by touching the tips of the tongue to a piece of steel of 0° F. temperature, or lower. This suggests that the sensation of great cold is a blend of warmth, cold and pain like that of great heat.

The sense organs in the skin are capable of extraordinarily fine discrimination. Maximal acuteness in this respect is probably to be found amongst the blind. An extreme instance is on record of a girl who can distinguish the denominations of bills when they are lying upon a smooth, hard surface by passing her finger tips slowly over the figures.

It has been demonstrated that words can be identified by their *feel* upon the skin of the hand if only the vibrations of a speaker's voice are communicated through a telephonic-like instrument to a receiver held in the hand of a "listener." The vibrations of the receiver feel different according to the words that are spoken. Sentences can be distinguished in the same manner so that the deaf can learn thereby to understand speech. More than this, difference in pitch, enunciation, accent, emphasis, rhythm and tempo can be recognized through the sense of touch. This affords a new method of control of the voice in the case of the deaf and others. But this point will be discussed in the chapter on Applied Psychology. It is not unusual among the blind to be aware through the sense of touch of the nearness of objects such as trees and posts in the yard and to avoid collision thereby.

Taste.—Elementary taste qualities are blended in almost infinite variety with smell, touch, temperature and pain. It is well known that when we are suffering from a catarrh of the nasal passages we are unable to distinguish foods and drinks by taste as we do normally. The same effect is produced when the nasal passages are tightly closed both anteriorly and posteriorly whilst food or drink is taken into the mouth. In such a situation, coffee, tea and quinine seem bitter and they cannot be distinguished in such circumstances. What distinctions one is able to make are determined on the basis of the "feel" of the foodstuff or drink in contact with the tongue and the walls of the mouth. Tasteable substances are then sweet, sour, bitter or salty or a compound of these with such other qualities as rough or smooth, warm or cold, heavy or light, painful or agreeable, etc.

But when smell, touch and temperature sensations are excluded there remain four genuine tastes: sweet, sour, bitter, and salty, and these can be completely isolated. These are elementary taste sensations, and each of them has its specific end organs. Those for sweet are found upon the tip of the tongue; sour upon the edges; bitter upon the base, and salty upon both the tip and the edges of the tongue. The specific organs are in the little pits upon the papillae of the tongue surface.

The stimulus to these organs is chemical in nature. Food or other substances, though in contact with the sense organs upon the surface of the tongue, cannot be tasted until they have begun to dissolve. If the tip of the tongue be thoroughly dried and a crystal of sugar be placed upon it no taste is aroused until dissolution of the sugar has begun in the accumulating saliva. But it very rarely occurs that a "taste" comprises but one simple quality. Almost invariably it is a blend of many qualities in which the whole appears as a unit. The taste of lemonade is a case in point. Besides odors and sensations of temperature and contact there are the simple tastes of sweet, sour and bitter, all of which are blended into what is called the "taste" of lemonade.

Odor.—The organs for sensations of odor lie in a small area in the upper nasal passages. They are in such position that currents of air entering either the anterior or the posterior nares—more especially the anterior—come into contact with it. In some form the stimulus to these organs is borne by the air current, for if the nasal passages be partially closed as in the case of a nasal "cold," the sense of odor is at least impaired. Undoubtedly the stimuli are chemical substances dissolved in air: they are gaseous. Only volatile substances, therefore, may be smelled. On the other hand those substances that, regardless of temperature, remain of the same weight precisely, day in and day out, that is substances that are non-volatile, have no odor.

No classification of odors on broad principles has yet been discovered. The one most frequently referred to is that of Linnaeus (1707-1778), who described seven classes. These are given below—with examples of each class:

1. Aromatic; turpentine, lavender, camphor, spices, butyric ether.
2. Fragrant; flowers, vanilla, benzoin.
3. Ambrosiac; musk, ambergris.
4. Alliaceous; garlic, assafoetida, Cl, Br, CS_2.
5. Hircine; cheese, sweat, rancid oil, lactic acid.
6. Repulsive or virulent; opium, nightshade family.
7. Nauseous; decaying animal matter.

The Dutch physiologist Zwaardemaker added two others to these:

8. Ethereal; fruits, some essential oils and ethers.

9. Empyreumatic; toast, tobacco smoke, tar, coffee, gasolene, creosote.

Henning, a German physiologist, in 1916 reduced the traditional list of odor qualities to six: 1, Flowery; 2, Fruity; 3, Putrid; 4, Spicy; 5, Burning; 6, Resinous.

A different type of classificatory work has been introduced by Sir William Ramsay and continued by Haycraft. These investigators find resemblances amongst odors of organic substances that belong to certain chemical groups. This is probably the most promising angle of approach to the whole subject.

Mixtures of odors produce widely varying results. In some a combination of two odors serves to cancel each—wholly or partially. Iodoform, for example, tends to destroy the odors that are more or less characteristic of the sick room, and creosote has the same effect in relation to many unpleasant odors. The odor of gardenia cancels that of orange blossoms; Peruvian balsam cancels the odor of iodoform.

On the other hand certain combinations of odors produce another that is totally different from either component. Xylol and turpentine afford an illustration. Once more, some mixed odors are given off by simple substances. If, for example, proprionic acid be smelled for some time the original odor undergoes an alteration of quality. In such a case it appears as if two or more olfactory sense organs, or groups of organs, have been active at the outset and that one of them has become fatigued (or adapted) in the process of smelling.

There is finally the phenomenon of adaptation. On first contact the agreeable odors of flowers, the disagreeable odors that characterize a crowded auditorium, and the like, are quite distinct. After a period of uninterrupted stimulation, however, these sensations disappear. The sense organ has become dulled, as we say, and we are wholly indifferent until the stimuli have been removed and returned to us again after an interval.

These phenomena of cancellation, mixture and adaptation are superficially, at least, analogous to similarly described phenomena of vision.

The sense of smell like that of touch is shown, by many well authenticated instances, to be capable of extraordinarily high development. Perhaps it is truer to say that there are very wide individual differences amongst people from the viewpoint of their capacities to make fine distinctions by means of smell.

Professor James has described the blind patient in a public institution who was able to distinguish the clothing belonging to other patients as it came from the laundry, and to do it by smell alone. A normal young woman who is known to the author is able, with 90 per cent of accuracy, to distinguish the odors of analine dyes in Holmgren yarns.

Such phenomena as these are possible *undoubtedly* only when a more than ordinarily sensitive organ is given. But beyond this it is certainly equally true that training involving the development of habits of attending to stimuli is equally effective.

The Kinaesthetic Sense.—As the name indicates this suggests sensations of movement of the body and parts of the body in detail. The classical experiment by Goldscheider is significant in this connection. When the free arm of a subject was resting passively upon a hinged board that could be elevated or lowered at the will of the operator, it was found that as small a movement as one-half of one degree could be detected. The fine discriminations of the pianist at the keyboard and the vocalist in the act of singing are, no doubt, in considerable measure, of the same character.

If an anaesthetic be applied to the skin of the subject's arm prior to flexing it the capacity for sensing movement will not be eliminated or even reduced. The meaning of this is that the organs must lie either in the muscles and tendons or in the joint surfaces or in both. When these possibilities respectively are controlled, it becomes apparent that the seat of the kinaesthetic sensation organs is in the muscles—in certain nerve end organs amongst the muscle fibers. These sensations are of extraordinary importance in connection with the control of our bodily movements and for that matter even in relation to the initiation of such movements. Such matters as these, however, may more appropriately be discussed later in connection with voluntary action.

Organic Sensations.—The most definitely isolated and localized of organic sensations are hunger and thirst. Hunger undoubtedly accompanies the contractions of the walls of the stomach which occur when the system has too little food to satisfy the requirements. When the sensation of hunger is most intense the contractions are extreme. This suggests that the sensory end-organs concerned are to be found in the walls of the stomach, and that their adequate stimulation is in the pressure or friction brought to bear upon them by the contracting stomach wall.

The sensation of thirst appears to have its seat in the walls of the mouth and pharynx. It is indicative of an insufficient supply of water in the system. It can be relieved by taking fluid into the system by way of the mouth, by injecting it artificially into the circulation or by the simple expedient of washing the mouth and pharynx with water or citric acid. This suggests that the end-organs for this sense receive their stimulation from a drying of the walls of the mouth and pharynx in which the organs are situated.

Other organic sensations are numerous: for example, sensations of pressure in the thorax and abdomen: of warmth and cold localized within the body, etc. All these sensations are more diffused, less sharply localized, than are those of vision, audition, and the like, and the meaning of this is probably that the sense organs are widely distributed through the organism rather than brought together in small compass as in an eye or in an ear.

We shall have occasion to revert to these sensations later when we are ready to discuss the emotions.

Weber's Law.—The ticking of a watch is impressive in the dead silence of the night but it cannot be distinguished in the din of a boiler shop. The reflection from a flaming candle very distinctly lightens the room that but a moment ago was completely dark, but it makes no distinguishable difference when it is thrown into the same room that is already illuminated by many incandescent lights. The doubling of a gram weight upon the hand is distinctly felt, but it is only just distinguishable when the same gram weight is added to two others that are already upon the hand. Such as these are facts with which we are familiar every day. They suggest the possibility of a constant relationship between the intensity of a stimulus and the intensity of the sensation that is occasioned thereby.

A certain correspondence here has been determined and it is expressed in terms of Weber's Law. Whatever the absolute value of a stimulus, it must be increased by a proportionate amount in order that, on the side of sensation, a difference may be noticed. Let us assume that a thirty-gram weight is resting upon the palm of the hand and that when a three-gram weight is added the total seems to be just heavier than it was before. Then if the original weight was sixty grams, six would have to be added; 120 must be increased by twelve, etc. At every point in the scale of weight one-tenth must be added to a stimulus in order that an increment may be distinguished and the same amount must be subtracted to enable the subject to detect a decrease in intensity of stimulus.

In similar manner one one-hundredth must be added or subtracted in the scale of brightness and even less in that of pitch. In every scale of sensation intensities from the just noticeable to the maximal, it is assumed, there are a great number of steps or degrees of sensation intensity. Each of these degrees in the ascending scale is just noticeably greater than its immediate predecessor, and the stimulus required to produce it may be found in advance by multiplying the immediately preceding stimulus by one plus the constant proportionate increment of itself (in the scale of pressure intensities, add one-tenth of itself).

The relation we are discussing here holds only over the middle course of a given scale of qualities.

Conclusion.—We have now concluded our survey of the capacities of the organism to receive impressions from the external world and to react to them in the sense of distinguishing differences. We have to conceive of the sense organs as so many avenues through which the organism may became acquainted with itself and with other aspects of the world in which it lives. Furthermore, the number of these avenues together with the number of distinctions that can be made within each of them affords a rough indication of the number of adaptations that the organism is capable of making. It has been estimated that the normal human ear can discriminate, within the sphere of tonal sensation, upwards of 11,000 different pitches, and of sensations of noise upwards of 500. The normal eye is capable of distinguishing probably 600 differences of brightness and perhaps 16,000 differences of color. Nobody has estimated the number of distinctions that can be made within the scope of tactual, temperature, gustatory, olfactory and other sensations respectively, but each of us can easily believe that the grand total is sufficient to stagger the imagination. But of course this is not the whole story by any means for we react also to different sensory qualities in combination. To obtain an absolutely complete picture, therefore, we must in some way extend our estimate far beyond our capacities to react to isolated sensory stimuli, and yet more than that, we must recall the possibilities that lie in the way of training. One can greatly increase one's capacity to distinguish pitches, brightnesses, etc.; one can acquire the capacity to discriminate spoken words through atmospheric vibrations conducted mechanically only to the palm of the hand or to the tips of the fingers as Gault has shown in experiments with the deaf; to distinguish pitch by way of the fingers alone resting upon the frame of a sounding piano; to differentiate the odors of analine dyed yarns and to associate the idea of color with odor.

Putting it in a general term, the sensations that arise from the functions of eyes, ears, olfactory and taste organs and from the great mosaic of receptors in the skin are essential to knowing the *external* world. Those that come from end organs in our muscle tissue and in our joints are a foundation stone indispensable to bodily activity and to voluntary action. The group of organic sensations, finally, are a *sine qua non* of our emotional and affective life.

CHAPTER VI

ATTENTION

> "The faculty of attention is not, therefore, a special faculty, but merely consciousness acting under the law of limitation to which it is subjected. But whatever be its relations to the special faculties, attention doubles all their efficiency, and affords them a power of which they would otherwise be destitute. It is, in fact, as we are at present constituted, the primary condition of their activity."—
> Sir William Hamilton.

Attention a Selective Process.—It would be an error to suppose that every stimulation of an organ of sense arouses a "sensation." Our sense-organs are being perpetually bombarded by stimuli. Eye-gate and ear-gate and all the other numerous gates of sense, external and internal, are continuously crowded with impressions desiring admittance. But only a few of them can be attended to in such wise that we become conscious of them. What a chaos of impressions life would be were we to notice every object or feeling of which, from moment to moment, we might conceivably be conscious. How helpless the mind would be in the presence of such a confused and disordered manifold of sensations!

It is apparent, then, that some kind of selective process occurs which determines which stimuli shall arouse a conscious response, and which shall not. This process, whatever its nature, admits the important and excludes the unimportant, receives the significant and rejects the trivial. To this process we give the name of the *attentive* process, or, more simply, we call it *attention.* It is through the operation of this selective activity that certain perceptions or ideas are admitted to the "focus of consciousness," while others are kept off the stage.

We may say at once that attention is not a *special* process or faculty. It is the mental process itself in one of its aspects or showings. Selection lies at the very heart of consciousness. To be conscious is to discriminate, to note this rather than that, to decide, to prefer—in a word, to select. The truth of this remark will be emphasized again and again in the course of this book. Our present chapter is, however, very important as revealing the essential nature of the conscious process. Psychologists have varied very greatly in the degree of emphasis which they have placed upon the study of the attentive activities of man. It is our conviction that this study is absolutely vital, and that without a sound understanding of the phenomena which are commonly discussed under the title of the present chapter the student must fall short of apprehending the central problems of our science.

The Outward Marks of Attention.—The attentive process has certain characteristic signs by which we recognize its presence or absence in other people. The person attending has a certain attitude and engages in certain kinds of movements. This attitude and action will vary, of course, according as the object attended to is *sensorial* or *intellectual* in nature.

If the object is something present to the senses we observe, first of all, a focusing of the sense-organs upon it. The fixation of the eyes upon the object is, perhaps, the most familiar indication of attention, since the movements of the eyes are so easily observed. It is just this circumstance, indeed, that leads people to observe the eye-movements of others, and gives the eyes their traditional preeminence as indicators of mental attitudes. Where several objects are concerned the eyes will be seen to move rapidly from one to another of them; they will be "bright," open, and alert in action. Where the object attended to is a sound the head is turned to catch the stimulus to the best advantage, and there is a general suspension of superfluous movements of the body, while breathing is often suppressed. Likewise, whether we smell, or use the cutaneous senses, or depend upon kinaesthesis, attention involves certain characteristic signs which indicate the presence of a strain, an *effort at observation.* The person shows, by his external attitudes and motions, that he is making vigorous use of his sense organs with reference to the object of his concern. It is, in fact, from reference to this overt effort that the term "attention" is derived; for it means, in its original form, a "stretching out to meet."

When a person is giving attention, however, to an intellectual object, something thought about (imagined, remembered, reasoned) rather than sensed, the characteristic play of the sense organs is absent, or at least only incipient. But intellectual attention may involve, nevertheless, quite as much strain and intensity as the sensory kind. Such external signs as do appear—in the first place, a certain tenseness in the position of the body, a wrinkling of the brows, a checking of the breath—would seem to point to effortful concentration similar to that involved in sensory attention. Frequently, too, there are obvious efforts to *exclude* sensory stimuli. The eyes are closed or averted from all distracting stimuli; sounds are excluded by turning away from them or by covering the ears, in extreme cases, with the hands; the arms are folded or the hands clenched. There seems to be an attempt on the part of the person attending to put himself into the best possible position for excluding *present* objects and for concentrating upon *absent* ones.

Thus attention is never a passive state in which an individual merely opens the gateways of the senses so that stimuli may flood in upon them, but rather an active and preferential process, in which there is an excluding of certain stimuli and a concentration upon others. To attend is to *do* something, is to engage in positive action. Purpose, anticipation, selection, are visible even in the external aspects of the attentive process.

Motor Accompaniments of Attention.—Attention, however, is not wholly a matter of the senses and of the imagination. It is just as surely a matter of muscular selection and adaptation, whether this be incipient and tentative or overt and visible. There are, of course, the muscular activities involved in the adjustment of the sense organs themselves. Again, there are many supplementary movements, such as leaning aside, walking about, using the hands in examining objects or in removing obstructions for the sake of observation. Sensory activity, in fact, cannot get very far without these motor aids.

But besides these movements we find many evidences (especially in sensory attention) of an inward process of selection and adjustment involving the whole motor mechanism of response. This cannot be mistaken where the attentive process is especially directed to the business of finding adequate motor responses, as in all forms of athletic exercise. The attending person can be seen to make sudden starts, this way or that, which are restrained; or he is relaxing, gathering himself up, moving always with the situation and seeking to select the proper responses to the stimuli presented.

And in intellectual attention, likewise, if we are observant, we find that motor selection is under way. If we follow out this clue we must come finally to the conclusion that attention is not a matter having to do with our presentations (sensations and images) alone, but with motor adjustments as well. In short, attention is not exclusively either sensory or motor, but is *sensori-motor*. The older psychologists called attention a "central" process, and represented it as intervening between stimulus and response. We may better express the truth thus suggested by saying that attention is a selective process which reacts into both the senses and the motor organs, conditioning perception and response alike.

Where attention is directed upon objects that do not call for immediate response (and especially intellectual objects) the motor aspects of the processes are not easily detected. They are present, however, in the form of tentative movements, changes of nerve potential and of muscular tonus. We know, moreover, that attention is accompanied by extensive internal changes, such as involve the blood pressure and circulation, rate of pulse, depth of breathing, glandular activity or suppression. This reaction of attention upon the sympathetic nervous system shows that its scope is extensive as well as profound. It touches the whole organism.

Introspective Aspects of Attention.—With this brief notice of the external aspects of attention let us proceed to inquire, What is attention for the person who is attending? How may it be described from the introspective point of view? Those who have studied attentive consciousness from this side inform us that its chief characteristic is *clearness*. In fact, some of the introspectionists *define* attention as clearness or vividness. They seem to mean that when an object is attended to, it is experienced as clear and vivid, whereas decreasing attention implies increasing vagueness.

These students likewise inform us that attentive consciousness has a *focus* and a *margin*. There is that in the experience which stands out clearly and adequately, but it is fringed by contents which are less clear. Says Titchener: "There is experimental evidence that, when our sensations are thus arranged, their vividness and obscurity are, as the arithmetics say, inversely proportional; *the more vivid the central processes, the more obscure are the marginal;* or, in untechnical language, the more we are concentrated upon any one thing, the less liable we are to distraction by other things.'' As, in the visual field, there are objects that impress the fovea and are clearly seen, whilst other objects affect the periphery of the retina and are only dimly sensed, so in attentive consciousness as a whole there are items that are vivid, constituting a kind of core or center to the experience, and others that are vaguer, making up a kind of margin or fringe to the conscious field. We must be careful with this analogy, however. The items that occupy the focus of consciousness are not in a *spatial* center, since our experience is not laid out on a plane surface, nor is consciousness often spatial in any sense. Focus and margin are figurative terms.

We may conclude, then, that when objects (whatever their nature) are attended to, they stand out more clearly and distinctly than before. They move into the ''focus'' of consciousness, while other experiences give way before them or sink into the margin. All this accords with common experience, and is what we might reasonably anticipate. For we attend to things with no other object than to make them clear. We want them to stand out, show themselves, reveal their qualities, traits, essential features.

We have said that objects attended to become clear and vivid, but the terms need explication. In what sense do things become clear, and to what effect? *''Clearness,''* says James, ''so far as attention produces it, *means distinction from other things, and internal analysis and subdivision.''* Attention is accompanied by discrimination, analysis, and relational activity. So closely does attention draw the higher intellectual functions in its wake that we cannot at any line say, ''here ends attention and here begins ratiocination." But, of course, many of our attentive processes do not call for profound mental response. Many of them, perhaps most of them, are fleeting and shallow and fail to penetrate the object to any depth. In any act of attention, nevertheless, there is always *some* showing of details and qualities not before apprehended, some new insight, however trivial, into the character of the object. If this were not so the act would seem to be pointless.

The Forms of Attention.—Let us attempt, continuing our survey of the more outstanding traits of the attentive process, a classification of the kinds or forms of attention. Were we attempting a profound bit of research here we should be compelled to maintain that there is, after all, only one "kind" of attention, which shows itself in various relations and under differing circumstances. Fortunately, our inquiry moves on a rather obvious and common-sense level, where it may be permissible (following custom) to speak of the various kinds of attention without danger of theoretical entanglements. In this classification of attention forms we can do no better than to follow William James, who identifies six types of attention as follows:

Attention	Passive (Reflex, effortless)	Sensorial	Immediate
			Derived
		Intellectual	Immediate
			Derived
	Voluntary (Active)	Sensorial—Derived	
		Intellectual—Derived	

(1) *Passive sensorial immediate* attention is such as is aroused by intense or naturally exciting sensorial stimuli. Loud sounds, bright lights, strong smells, tastes, pains, or such sensations as are aroused when some creature crawls on the skin, are examples of sensory objects which we at-

tend to naturally, inevitably, and without effort of will. Our attention to them is *immediate* because they are noticed on their own account without ulterior motives. Children are invariably attracted by these exciting stimuli, and even adults must give at least momentary attention to them. They have a disagreeable way, at times, of forcing themselves upon our attention when we should prefer to concentrate upon affairs more consequential. Hence they come to be classified, by conventionalized adults, as nuisances.

A great deal is made of such stimuli by certain classes of merchants who wish to boom their sales. Loud noises, flashing lights, moving devices, vividly colored posters and displays are common enough phenomena on our streets. In the long run, however, such attention catchers are found to be inefficient for most purposes, since the adult mind usually lets go of them as soon as they are noticed.

(2) *Passive sensorial derived* attention occurs when a sensory object is attended to, not for its own sake, but because of something with which it is connected. A sound or light which is attended to as a *signal* is a case in point. To quote James's apt illustration: "A faint tap *per se* is not an interesting sound; it may well escape being discriminated from the general rumor of the world. But when it is a signal, as that of a lover on the windowpane, it will hardly go unperceived." Whenever, then, we attend to a sensory object because of its associations, because it bears in some manner upon some thing beyond itself in which we *are* interested, our attention is of the second type. Such attention, let us observe again, is maintained without effort of will.

(3) *Passive intellectual immediate* attention occurs where some train of images, memories, or ideas is intrinsically interesting and carries us along with it. This is, in most respects, the most effective and praiseworthy type of attention. The student who can become utterly absorbed

in a line of reflection, the inventor who can lose himself in the intense pursuit of an idea, the mathematician who can pursue a solution indefinitely without external incentive, are, we think, gifted above ordinary mortals. But all of us, at times, feel ourselves lifted on the wings of some thought and carried away with it. Such is attention of our third type. It is when attending in this way that men become "abstracted" or "absent-minded." Present affairs are completely excluded from consciousness in favor of some absorbing line of study. We must take care not to confuse this *attentive* state with those states in which we drift idly along the stream of time with our sensations, moving towards sleep. Attentive consciousness is always dynamic.

(4) *Passive intellectual derived* attention occurs in those cases where we attend to some thought for the sake of something with which it is connected or to which it leads. Thus many a man who abhors mathematical calculation will give perfectly absorbed attention to a bit of figuring that has to do with his bank account. It is not very often, however, that we give *passive* intellectual attention to objects in which we have no immediate interest. It takes a powerful motive to induce it. Thus, when it was the fashion, many a young man would lose himself in the composition of a poem wherewith to express his sentiments to his lady fair. The means partook of the end, and attention was absorbed in the verse-making itself. This type of attention, however, in its pure form, is rarely met with.

(5) *Voluntary attention* is always of the derived kind. We never force, or compel ourselves to attend to objects that are intrinsically interesting, but only to such as are related to remote interests. Voluntary attention seems to require a push from behind. We "summon our wills" to compel such attention, and call up the whips of conscience and the spurs of good or evil prospects.

Voluntary attention is *sensorial* when we attend by effort of will to a sensory object. Thus, when we compel ourselves to attend closely to the fluctuations of a thermometer, or to the color-changes of a chemical process, because these observations are a "part of the job," our attention is voluntary and forced.

(6) *Voluntary intellectual* attention is of the type most familiar to students and the theme of many a preachment. Listening to a lecture, for instance, whose content is intellectual, may involve no end of "will power." Distracting stimuli of all kinds press upon us, and must be resolutely held back while the speaker's ideas are given right of way. Study presents similar difficulties when the subject-matter is not regarded as interesting in itself, but when we force ourselves to understand it for the sake of some future good. Voluntary attention, as such, is seldom sustained and continuous. Outside thoughts will intrude themselves, and the stage of the mind must ever and anon be cleared of these distractions. The attention to the object proceeds by a series of dwindlings and jerks, which process is not calculated to produce the best results. The hope is that by an initial voluntary attention the student may eventually find himself giving passive and effortless attention to the subject. If this does not occur his studies are not apt to prove fruitful.

The Duration of Attention.—In view of what has been said concerning the varieties of attention or, more properly, concerning the conditions under which attention operates, it will be evident that no direct and unambiguous answer can be returned to the question, How long can we attend to objects? This topic has, however, strongly engaged the attention of psychologists, and deserves some comment here.

In the early days of modern experimental psychology it was the custom to present *faint stimuli* and ascertain how long an observer could keep them in the "focus" of consciousness. When such stimuli are presented—the barely heard ticking of a watch, for instance, or a faint dot on a white background—it happens that in a few seconds they pass completely out of the observer's experience, in a very realistic sort of fashion, as if they had been silenced or wiped out. Presently, however, they appear again. Thus they continue to come and go. It was concluded, accordingly, that attention is subject to regular shifts or pulsations. In the long run it was decided that physiological conditions, especially in the sense-organs, are largely responsible for these changes. Attention to faint stimuli puts a strain on organs and produces fatigue effects, which result in actual periods of exhaustion and recovery. Some hold that fluctuation is due to a rhythmic ebb and flow of nervous energy to the muscles of adjustment. There are, however, subsidiary considerations which point to a natural rhythmical movement of attentive consciousness itself. Thus, in listening to the beats of the metronome, or the regular clicks of car-wheels on the rails, we tend naturally to break such sounds into groups of a rhythmical character. No doubt a part of the explanation of this tendency is to be found in the relief which it affords from the strain of monotonous attention. Anybody who has driven an automobile knows that attention—conscious attention—to the task is intermittent rather than continuous, even when we desire it to be otherwise. In listening to a speaker we demand the periodic pauses which provide opportunity for relaxation and mental assimilation. In voluntary attention, as we have seen, attention is usually fluctuating, alternately relaxed and then forced back into its prescribed path.

Basically, however, this fluctuation connects itself with the thought that attention can never be static, but must always be on the move. The best comment that has ever been made on this subject of the duration of attention is this, that we *can attend continuously only to objects which develop.* Attention is not ecstatic contemplation. It is an active performance, and its business is to make clear the uncertain and vague. In attending to things we are always *reckoning* with them, calculating their possibilities in the way of threat or promise, or of constructive effort. Only the objects that show something in the way of possible bearings upon our interests or plans can continue to hold our attention, and these only while their possibilities remain unexhausted. While they continue to reveal hidden aspects, new qualities and sides, so long does our attention stay with them. *In the instant in which an object becomes "clear," attention leaves it and passes on.* On the other hand, an object which is capable of showing us new traits, of renewing itself in an endless unfolding of aspects, is able to keep us occupied for minutes, perhaps hours, at a stretch. Insistent voluntary concentration on a stupid, quickly exhausted object will, in case no rival object bids successfully for favor, lull the observer into sleepy nonchalance. But, of course, the stupidity of an object is directly relative to the training and experience of the observer. Even the most humble things present innumerable possibilities to the resourceful mind.

The Scope of Attention.—How many objects can we attend to at one and the same time? This question must be carefully considered, since objects are single or multiple according to the "set" of our perception.

A great many experiments have been made from time to time with the view of determining the "span of consciousness." Some of them belong to the "pre-scientific" age. Thus Sir William Hamilton: "By Charles Bonnet the Mind is allowed to have a distinct notion of six objects at once; by Abraham Tucker the number is limited to four; while Destutt Tracy again amplifies it to six. The opinion of the first and last of these philosophers seems to us correct. You can easily make the experiments for yourselves, but you must beware of grouping the objects into classes. If you throw a handful of marbles on the floor, you will find it difficult to view at once more than six, or seven at most, without confusion; but if you group them into two's, or three's, or five's, you can comprehend as many groups as you can units; because the mind considers these groups as units—it views them as wholes, and throws their parts out of consideration.'' Modern experiments with special apparatus for exposure, to prevent more than one ''look,'' show essentially the same results, except that we cut our limit down to five objects at the outside.

This result is no doubt valid and of interest. It does not, however, answer the question, How many objects can be *attended* to at once? It is an answer to that other query, how many objects can be *counted* under this set of conditions? Even here, as James observes, what is really tested is the keenness of the observer's vision and his command of geometrical patterns. The effectiveness of the counting depends, also, upon the distinctness of the after-images.

The question which we have raised cannot be answered until we have decided what is to be understood by an ''object of attention.'' If an object of attention is that something, multiple or simple, to which attention is exclusively directed in a situation, then, of course, there is only one such object by the terms of our definition. If the object is whatever occupies the ''focus'' then, of course, there is only one focal object. The whole discussion is complicated by the circumstances that we confuse physical and psychological terminology. Let us remember that attention is not controlled by the objects, *per se,* for if it were all our attention would be involuntary. Attention ''takes'' objects as one or many, according to the nature of the task in hand. From a psychological point of view it seems best to say that attention has, in a given moment, only one object, remembering that this may be a sensory point or a whole situation.

It seems, at first glance, much simpler to ask, How many *processes* can be attended to at one time? Here the answer is unambiguous. Only one. It is true that one may walk, whistle, and read a poster, all at once. But these so-called separate activities are so automatic and mutually agreeable that they require no special attention. Let the walking, for instance, present difficulties, and it forthwith monopolizes attention to the exclusion of the other processes, which are often suspended entirely, pending solution of the matter in hand. These operations can ordinarily be carried on together without effort because, as we say, they require no attention, but reel themselves off automatically, when once they are let go, and attention has to see only that they do not conflict. For similar reasons a man may recite a poem, write another poem, and beat a tune with his feet, all in the time that would be required for the execution of any one operation taken alone, provided that by practice he has fused the separate processes into a single performance which he may attend to *as* one.

Attention, then, cannot be broken up into a number of separate acts of attention, each with its own object. For the intention and aim of the attentive process is unity, organization. Its fundamental function, as we shall see, is to keep experience harmonious and in balance. There is only one attention, and it may be directed upon one or many objects as the occasion demands, but it has regard for their number-traits only as occasion requires that they *be* numbered.

The Determinants of Attention.—So far we have been observing the more obvious characteristics of the attention process. We come to closer grips with our subject when we inquire: What is it, in a given situation, that determines which one of a number of possible objects shall be attended to exclusively? Why does the individual attend to this particular topic when he might be attending to that? Our attention is directed by some sort of process, on its chosen objects, and it ought to be possible to indicate, at least in a rough and common-sense way, some of the factors that affect the preferences of attention.

To begin with, then, the character of the objective stimuli present in a given situation will have something to do with determining the direction of our attention. In discussing ''passive sensorial immediate'' attention we have seen that attention is naturally drawn by intense stimuli. The intensity of the stimulus is partially conditioned, however, as psychologists have observed, by the processes of the sense organs themselves. A stimulation will be intense, that is, when a sense organ has been worked up to a certain pitch of excitation, whether this be due to a sudden burst of energy from an object or to a slighter but steadier flow of energy which affects the sense organ cumulatively. Intense stimuli, then, will attract involuntary attention.

We know also that movements, or changes in the quality of experience, attract our attention. ''One notices,'' says Pillsbury, ''a whistle of changing pitch or intensity where a constant one would escape notice. One even appreciates the ticking of a watch as it stops, although the preceding continuous ticking has not been noticed at all. Similarly, objects that move towards or away from us are noticed, although the same objects would escape notice if stationary, and our only way of knowing that they move away or approach is from changing size. Change, whether in size of intensity, whether it increase or decrease, will attract attention.'' It is true, then, that *objective* conditions do exercise a considerable influence on our attentive activity. The underlying reason for this circumstance, from the psychological point of view, would seem to be that objects which are intense, or which move, or produce movements, have power for good or evil above inert things, as affecting our fortunes. We have a natural or "instinctive" tendency to notice objects which have to do with the preservation of life and limb, the securing of food, or the furthering of our practical interests. If attention, in relation to such objects, is somewhat reflex or mechanical, it is because prompt attention to such objects, in the history of the race, has proved necessary and expedient.

In our ordinary civilized life, however, the *subjective* determinants of attention seem to be most potent and significant. Following Pillsbury's general plan, we may list these under the following heads: (1) Transient ideas or impressions, (2) the general purposes or attitudes of the moment, (3) earlier education, (4) the pressure of social demands or ideals, (5) hereditary dispositions.

Transient ideas or impressions, such as drift through the mind from time to time, and carry other thoughts in their wake, may often lead us to attend to objects or thoughts which would otherwise remain unnoticed. If at this instant I happen to be thinking of Verdi, I may notice an Italian name in an advertisement which would otherwise have passed unremarked. If I have been casually thinking of odors, it may happen that I will observe odors which would otherwise have received no attention. Any topic attended to directs our attention to other facts or experiences that are in keeping with the general mood or logical line of associations which it suggests. This rather accidental determination of attention by transient ideas can occur, of course, only in fairly passive and relaxed states of mind.

In more strenuous moments, where the idea in mind at the moment forms a part of a systematic train of reflection, the effect will be similar but more assured. If one be actively engaged in thinking about some person, event, or object, then by reason of this "set" of mind the person will inevitably be noticed if he appears, or the object attended to if it comes within range. Where the mind is preoccupied by certain ideas there is a strong tendency for attention to fix upon matters related to the central topic of thought.

The general purpose or attitude of the individual in any given situation is of undoubted potency as a determinant of attention. Where, that is, a person is engaged in a definite pursuit directed towards a foreseen end, the tendency is to notice only such things as bear upon the business in hand, and to exclude others. A good proof-reader will attend to the spelling of words, the form of the type, the style of punctuation of a composition, while excluding from his attention a great many ideas which might otherwise be suggested by the text before him. A student who is making reaction experiments with the object of observing his own kinaesthetic sensations will take little note of the sounds made by his instrument, or of the voices of people in the distance. What we shall attend to in a given situation, then, depends in considerable degree upon the attitude or "set" of the organism or upon the preparedness to act appropriately.

The previous education of the attending individual shows itself most clearly in the kinds of purposes that animate him. What we call the "character" of a person is largely constituted by the ideals, purposes, preferred interests, which actually inspire his acts and his thought. Some persons attend keenly and eagerly to music; to others it is a deadly bore. Some men will go out of their way a considerable distance to learn how to keep water from freezing in the radiator of an automobile; others would gladly forego all interest in things mechanical. Our hobbies, our professional interests, our social ambitions, our religious prejudices, these betray us by guiding our attention into its habitual channels, and giving notice to others of our scheme of values and our sense of the trivial and the important.

The formation and development of such purposes is, of course, a matter of education and social influences. Our past experience shows itself in the form of acquired tastes, prejudices, standards of judgment, nuances of emphasis, which lie embodied in our nervous systems. "Let four men make a tour of Europe," says James. "One will bring home only picturesque impressions—costumes and colors, parks and views and works of architecture, pictures and statues. To another all this will be non-existent; and distances and prices, populations and drainage-arrangements, door- and window-fastenings, and other useful statistics will take their place. A third will give a rich account of the theaters, restaurants, and public balls, and naught beside; whilst a fourth will have been so wrapped in his own subjective broodings as to tell little more than a few names of places through which he passed. Each has selected, out of the same mass of presented objects, those which suited his private interests and has made his experience thereby."

Social pressure and influences induce us to attend to certain objects very frequently, when, if left to our own devices, we would neglect them utterly and with joyful abandonment. This is so palpably true of certain of our intellectual tasks, for instance, that no comment is called for. In a more subtle way, however, the social standards of our environment and the patterns of conduct set by our superiors mold our judgments, set our scale of values, and thus determine our purposes and our conduct. If the truth be told it is likely that if it were not for what the older ethical writers called the "social sanctions" there would be but little hitching of wagons to stars. The extent of social influences upon the individual, as these are exerted in the home, the gang, the school, the business world, the club, the religious circle, are so subtle and all-pervading that they can scarcely be isolated and measured. Thought, at least such as is objective and utterable in language, is, some thinkers hold, socialized through and through. The potency of these social influences in the determination of the direction of our attention is, we must agree, very marked.

Heredity as a factor in the determining of attention is much more difficult to discuss than any previous subject because of the disagreement that clouds the whole subject of mental inheritance. Many psychologists hold that heredity is responsible for the specific bent of mind of the individual, for his peculiar talents and adaptabilities and his cast of temperament. In our opinion a great deal more evidence than is forthcoming at present will be required to establish the doctrine of inherited special capacities. At the same time it must be admitted that characteristic individual differences do show themselves at an early period in the individual's life, and distinguish his conduct thereafter.

We are prepared to admit, also, that as molding our *bodily* structures inheritance is of decisive influence in the mental life of the individual. Thus a lad possessed of a powerful physique is quite likely to be interested in sports, and in such activities in general as bring this valuable natural talent into play, whereas if the boy be frail he will quite naturally find his interest in less athletic pursuits. Even this statement, if taken too positively, is apt to be misleading. But, on the whole, it is impossible to avoid the conclusion that differences in bodily capacity will reflect themselves in differences in interests and thus in the direction of attention.

The General Significance of Attention.—The rapid and sketchy survey of the outstanding facts about attentive activity thus far made will serve to show, at the least, that attention is not only a profound activity but one practically coextensive with conscious life itself. In its operation it involves senses and muscles, memories and anticipations, purposes and ideals, habits and learning. At the same time we are confronted with an array of facts so varied and multiple that confusion seizes us when we attempt to understand attention as a function of the mental life.

But this need not discourage us if we remember that any kind of interpretation must take us outside the phenomenon itself to the wider sphere of reality which constitutes its setting. If we would gain any degree of insight into the attentive process we must regard it, not in its isolation (however interesting the merely descriptive account may be), but as a natural process related to other natural processes. In the case of mental phenomena this kind of interpretation leads irresistibly to a genetic study of consciousness.

Man and His Environment.—If, now, we revert to our discussion of the ''Evolution of Mind'' (in Chapter II) it will be remembered that we there succeeded, at least provisionally, in isolating the essential features of such behavior as may be called intelligent. Briefly, we found that even the Protozoa are given to exploratory activity, accompanied by a limited capacity to learn which, as we ascend the evolutionary ladder takes on more and more the appearance of definitely experimental activity. This evolution of the exploratory capacity, at least along the vertebrate line, is attended by a constantly increasing power on the part of individual animals to profit by past experience. Among the vertebrates we find the ''trial and error'' method of learning giving way gradually to independent observation and analysis, which evolves finally into the "ideal experiment" of man.

The more closely we scrutinize the features of human attention the more clearly we shall see that it represents an extension and development of these primitive animal tendencies. It will appear, in fact, as a phase or aspect of what we have been calling "ideal experiment." Its essential meaning, if that be true, can be rendered in biological terms, provided our biology be not too circumscribed and pedantic.

This standpoint requires us to remind ourselves that man is a living organism placed in the midst of a world of movement and change, potent with good and ill fortune. In a perfectly harmonious universe where everything stayed "put" and kept a pre-established pathway, there would be no need for thought, for learning, for attention. The balance of life would remain forever constant, poised amid the exact movements of predestined events. But the world is not harmonious. It is full of clash and discord, of strife and struggle. The organism that would survive and achieve mastery must be able to escape the destruction that threatens from earth and sky and water, from inorganic energy and organic rage. It must be able to anticipate and avoid danger, to turn to advantage the very forces which might, uncontrolled, bring destruction.

If, then, there has been a real evolution of organic life, from humble beginnings, it is because living things have been increasingly active in the endeavor to master natural forces. Life cannot remain passive and receptive. It is by nature aggressive and pushing. If the *élan vital,* the vital principle, of certain biological speculators is not a real entity, it is at least a potent conception wherewith to express an unmistakable characteristic of all things that live. All about us we find living beings, abundant and myriad-formed, pushing upward toward fuller life and expression through the hampering chaos of material nature. Sometimes life is crushed out by other life, sometimes forced into almost immobile forms of existence. But, in the main, it strives on as if it had *will,*—the will to growth and mastery. Inorganic matter is inert and receptive; organic beings are dynamic and responsive.

Attention, if we follow the line of thought thus suggested, must inevitably connect itself in our theory with this struggle for survival and development. As a form of activity its general *function* is to further the ends of human life, however exalted these ends may be. Let us see how well this suggestion accords with the facts of life as we know them.

When Do We Attend to Things?—Attention, as our previous discussion has shown us, is *anticipatory.* It involves always a degree of expectation, a premonition of advantages to be gained or of mistakes to be avoided. When we attend there is always something that presents itself as a problem to be solved. Attention seems to be called forth and rendered active in the presence of a problematical situation, and we may characterize it, provisionally, as a *problem-solving activity.*

There are many movements of attention that present reckonings too trivial, it might be said, to deserve the dignified title of "problems." In casual life attention flashes about continually, directed now to this, now to that object, with a quick touch and go that almost defies observation. There is, nevertheless, in any such movement, always some degree of anticipation, some forecasting of consequences, a bit of uncertainty as to the character or bearing of this or that item of experience. The nature of attention is no doubt better revealed in those more massive movements by which we summon all our resources to the solution of some momentous difficulty. What does our more serious thinking import, where there is no questioning, or our learned reasoning, where there is no problem? Here we see clearly that attention must have an object that presents a query, else our thought is footless and unmotivated. But all attention, however light its movement, arises in response to uncertainty and premonition.

We must not forget, in this connection, that while problems do come to him who only stands and waits, they present themselves more frequently to the individual with active ambitions. Any attempt to increase one's mastery of affairs carries with it an issue of perplexities and novel situations. Problems are generated by man's reaction upon his world, and the more vigorous his reaction the more numerous his problems. Hence he cannot remain at the stage of reflex and automatic habitual action. These direct and unthinking forms of response must give way, if we would advance, to the indirect form of action that we call attentive or conscious response. We must be alert, prepared for what is coming, and willing to find new modes of adjustment by attentive effort.

The Problematical Situation.—We have already answered the question, Why do we attend to things? Our answer is that we attend in order to solve problems. But there are problems and problems, of all degrees of acuteness and all varieties of content. There are problems about walking or driving nails, of digging ditches or constructing bridges, of mathematical analysis or religious belief. With us life is exceedingly complex, varied in its objects and situations, so that at every turn and stage it offers difficulties. Can we, then, in the face of this complexity, make any general statements about the problematical situation and its elements that will prove illuminating?

In the first place, as has been remarked, every such situation involves problematical elements. We use the term "elements" advisedly, at this place, for we must not overlook the fact that every attentive situation holds also its certainties and assurances. If this were not so our minds would explode under the impact of the questions hurled against them. Our problems come to us in a setting of solid realities, which give us the means necessary to their solution. We are here more concerned, however, with the problematical *quale* which occupies the "focus of consciousness" in any such situation. When we attend, we have a *blur* in our experience, which it seems to be the business of attention to remove. The introspectionists are quite right in their statement that attention results in clearness, although they have been remiss in observing the blur with which it begins.

The characteristics of this blur can best be illustrated, perhaps, by reference to a perceptual situation, where the problem is one of finding the correct response to a sensory object. If a subject be asked to respond to visual signals by pressing this or that key according to the signal presented, it will be found that very frequently, when the signals are presented, they are *perceptually blurred.* Vision is literally confused. This blur does not clear up until, by attentive effort, it is brought into the "focus of consciousness" and analyzed. Such an experiment might and often does appear to generate kinaesthetic blurs of similar character, which seem to result directly from a confusion of motor tendencies.

We should observe here, for the matter is crucial, that the blur is always the concomitant of sensori-motor stress and strain. It implies a bit of disorganization in the individual's system of perception and response: not a total disorganization, for that would involve a collapse of all sentiency. Somewhere, in the experience of the individual, there is an unresolved element which produces a tendency towards disequilibrium. Whenever such a situation arises the attentive process is set in motion, with the purpose of removing the blur, the disorganization, the experienced confusion. This statement will hold good for any problematical situation, regardless of its content or level.

Attention in Operation.—We have now arrived at a conception of the task which confronts attention. How does the attentive process proceed to clear up the blur which calls it into action? What is its *modus operandi* in reckoning with the blurred elements in experience?

Here we must proceed carefully if we are to avoid misunderstandings. We are in danger of falling under the spell of the simple notion that attention is some kind of special and *separate* mental process, or faculty. It is difficult, indeed, to prevent our language from carrying that implication. We shall deal more adequately hereafter with this subject of the inter-relations of the several mental processes which we distinguish. For the present let us recall that attention seems to accompany any and every conscious process. It is not specific, but general. Attention is an *aspect* of the mental life, not a special faculty, and therefore has no modes of operation such as might pertain to a single identifiable process.

This thought becomes more concrete as we reflect that the attentive situation is one of general aliveness. In the attentive process the many powers of the individual are summoned and marshaled, and concentrated towards the solution of the difficulty in hand. Attention rallies the senses and muscles to action, calls upon memory to deliver its stores, requisitions conceptions and local categories. It is characterized by the *gathering together of all the forces of our being into a single organ of action. It is "organismic" response and adjustment.*

If this language seems strained we may assure ourselves that attention is far too complex, in its inner nature, to lend itself to description in a simple phrase. Let us consider. How, for instance, does attention make things clear? There can be no invariable answer, since attention is not a particular process carried on by a special organ. If the difficulty is one of *perception,* then the sense-organs are focused on the object, and an attempt is made to clear up the blur by sensory means. If this will not suffice accessory motor activities are called into play. Or, again, the problem may necessitate the *remembering* of some fact or chain of circumstances that will resolve the doubt. Reasoning or inference may be called into play. Any or all of our powers may be called into operation, in accordance with the demands of the situation.

Attention is Analytical.—Attention "clears up" the blurs in our experience by first of all making them show themselves, in their detailed aspects, qualities, traits,—so far as this is possible. It proceeds first of all by analysis, a dividing, a detailed scrutiny of the object. Whether the object be perceptual or ideational, the movement of attention would seem to be, in the first instance, in the direction of dissociation and differentiation.

There is no simpler illustration of this analytical tendency than is furnished by the effort to discriminate an overtone within a complex tone. Once we have, by adequate preparation, been enabled to hit upon the overtone, it is found to stand out with startling distinctness. We have, as a result of this analysis, no longer one tone but two. The complex may be further resolved into parts, this depending on our acuteness and persistence. The experiment is attended with more strain of effort, however, than is usually experienced. Suppose a person be given a cup of tea, with an invitation to observe its astringency, bitterness, and spiciness. With this initial mental preparation the qualities will appear with rather marked distinctness, it is likely, even though they have never before been differentiated within the total complex called "the taste of tea." In these cases the analytical movement and differentiating effects of attention are easily detected. But in every attentive act objects yield up their obscurities and reveal unsuspected details, in an analogous manner.

This analytical process is very mysterious, in some of its aspects, and well merits the admiration which students have bestowed upon it. If its explanation is physiological it is at least not obviously so. In the case of the tea-tasting, for example, we should remark that the same taste-buds and organs of touch in the throat, the same olfactory membrane, have been stimulated in much the same way many times before. Peripheral conditions have not changed essentially. We are, then, driven in the case of physiological explanation to assume some kind of cortical activity which has power to split up the total impression received into distinguishable parts. But in the present state of our knowledge of brain action this hypothesis gives us little illumination.

Whatever the mode of operation of analysis, it has the result of **making possible "ideal experiment" by revealing the different aspects of the object from the standpoint of possible reactions upon it, and thus enabling the selection of the most effective response.** When certain qualifications are indicated this formulation will hold for ideal as well as for perceptual situations. Whatever the problematical object, we analyze it, taking it now this way, now that, scrutinize its various properties in relation to this possible treatment of it or that mode of evading it, until the one most effective reaction is finally selected and adopted.

The process is, in part, one of bringing past experience to bear upon the present difficulty. Analysis leans upon the past. It breaks up the object in terms of already achieved ways of regarding it. We strive to find the familiar in the novel, to assimilate the new to the old. Here memory and general retentiveness function characteristically. For this reason the nature of an individual's analysis of an object will depend to a great extent upon the resources which he is able to bring to bear upon the task.

Attention is Synthetic.—Psychologists have always observed that analysis goes hand in hand with synthesis, and some of them think that the latter is logically prior. In the very act of differentiating an object we are at the same time seeking to relate it to other objects. This is in line with certain statements above. For the business of viewing the new under the aspects of the old implies that we are seeking to assimilate it to our total experience-system.

In a more specific way, however, we may see that attention attempts to form new combinations and constructions out of old elements. Old modes of reaction are utilized in the formation of new complex response-patterns, old ways of sensing things are synthesized into new perceptions. The individual's habits, systems of response, no less than his ways of viewing objects, are thus being perpetually worked over and built into new forms. This note from James Ward's *Principles* summarizes the whole matter: "The proximate fact for the psychological observer is, however—this much, at least, we may safely say—a unity that is differentiated. But, though differentiated, it is not disintegrated. On the contrary, the further the differentiation proceeds the more apparent becomes the solidarity and consentience, the work of synthesis *within the whole.* In studying this synthesis, the analogies that guided Herbert Spencer in treating the same topic are the best we have; and psychology is much indebted to him on this score. . . At the beginning pronounced homogeneity, plasticity, potentiality, rather than defined features; at the end pronounced heterogeneity, structure, actuality—disclosing a person with unique traits. Yet first and last an indivisible unity."

Synthesis and analysis are not, then, separate movements, but moments within a single genetic process. We penetrate, by attentive effort, the complexity of apparently simple objects, behold their variety and multiplicity of aspects, while at the same time the movement of synthesis is continuous. So much for the manner in which our attentive activities operate. We shall deal hereafter at greater length with the means by which we organize our experiences and keep life balanced and effective.

The Effects of Attention.—Human experience, when it is normal, is an affair of growth and development prolonged even into old age. Our worlds present ever new appearances to sense and imagination; new differentiations are achieved, new adjustments are made. Life begins in feebleness, but in a feebleness that is the very condition of adaptability. In childhood our motor responses are unformed, our senses undeveloped, our purposes only potential. Little by little, as life unfolds, our actions become more definite and appropriate, our perceptions more penetrating and accurate.

Without interested attention no such growth would ever be possible. The capacity to learn trails in the wake of our ability to attend. It is this consideration which forces upon us a genetic explanation of attentive action. For, as has been said, attention does not merely assist us over difficulties as they arise. Its effects are *cumulative.* Every gain made by attentive effort is conserved by our retentive powers. By such effort we attain to a coördinated nervous system and learn to apprehend the world in ordered sequence and system.

Let us remind ourselves, once more, that if man were like certain of the instinctive creatures, a being of reflexes and mechanical responses alone, his attentive powers would be an idle and useless luxury. In the life of the individual insect, learning (in the human sense of the term, of course) is at a minimum. Growth is merely spatial. There is no evidence of psychical *development.* And there is almost nothing, in the conduct of these creatures, that corresponds to what we call attention in man.

The reason for this is that problematical situations, and attentive reaction to them, can scarcely arise in creatures whose ways of doing things are specified after the mode of instinct. Everybody knows what it means to carry on an activity like walking under familiar conditions. Here the activity reels itself off, in its accustomed form, and no consciousness of the movements involved is either desirable or forth-coming. Suppose that human activity were through and through of this stereotyped form. How could attentive consciousness ever arise? Attention is understandable only in the light of the plastic, modifiable, learning, growing nature of man.

Such attempts as have been made in the course of the history of psychology to reduce all human conduct to the reflex and mechanical type must, in the light of our preceding analysis, be dismissed. Human life is psychical, if psychical at all, through and through, and not merely in some detached portion of our being called the "mind." How, it may be asked, can a physiological being like man be capable of *psychical* activity? What would such a phrase mean when rendered in concrete nerve-terms?

In view of certain recent theoretical tendencies in psychology these questions would seem to press for an answer such as will, at least, justify the position we have taken.

The Physiology of Attention.—Scientific literature on the subject of the physiology of attention is very limited in quantity. That attention is a matter of inhibition and reinforcement, of synapse resistances, of changing potentials within the nervous systems—we frequently read and acquiesce in. But such explanations are immature and hopelessly vague. We cannot hope, here, to say anything about the intimate nature of nerve processes that will serve to clear up the situation. We may be able, however, to indicate the *general* direction in which neurological explanation must move if it is ever to arrive at a satisfactory theory of the attentive processes.

The cardinal error in our physiological explanations, as it appears to us, is that it depends upon the *constants* of the nervous system for its interpretations rather than upon its *variables.* Attention, as we have seen, is unintelligible apart from plasticity and learning, and learning involves, from the neurological side, a genuine construction within the nervous system itself. It will be our present task to reinforce this fact, and show its importance for any theory of human behavior.

Reflex Actions.—Let us recall here, briefly, certain facts set forth in a previous chapter on the nervous system. Man is capable of carrying on a number of activities that involve, so far as we can see, no consciousness, and hence no attention. They never *have* involved consciousness; have never been learned. The most absolute of reflexes, of course, are those concerned with the vegetative processes of the body. Except as they affect the general state of the body, they give us no concern. Then follow in logical order the overt reflexes that we are born with, the sucking, crying, gasping reflexes which seem perfectly automatic in their functioning, at their first appearance. After these the reflexes such as winking, which represent more positive reactions to external stimuli.

Within certain limits these reflexes are subject to direct or indirect control, but, on the whole, we reject responsibility for their functioning. They seem somehow to belong to that body which we refer to as the seat of our "animal" natures, as contrasted with our "higher" natures. The reflex type of action is not, we must agree, the typically or distinctively *human* mode of response. It seems strange, in view of these everyday facts, that so many attempts should have been made to show that it is the universal mode of nervous processes.

Let us consider once more just what is involved in a reflex response. Here nervous connections between sense organs and muscles is direct and constant. Let the adequate stimulus operate and the preëstablished response will occur in routine order. The reflex depends upon something *fixed* and *final* in the structure of the nervous system. The explanation must be in terms of nervous constants: permanent structures. But even in case of reflexes, in so far as they are modifiable by their nervous contexts, there ought to be some provision for variation. And, of course, a great many neurologists have made such provisions, while yet retaining so far as possible the mechanical conception of the reflex arc.

From the standpoint of conscious life the characteristic of the reflex is that it represents little possibility of choice or selection. *Response is largely determined by stimulation.* What an individual's responses shall be, in a given situation, if we follow the logic of this plan, depends exclusively upon the external situation. There can be no such thing as genuine *initiative* on the part of the experiencing subject. He is a pawn in the play of cosmic forces; a thing of buttons, wires, and levers. His movements depend upon the combination of stimuli that at any time happen to play upon his mechanism. Such a creature, very palpably, would have no "mind of its own." Why should it have? Nature obeys the law of parsimony.

From a certain limited practical point of view such a theory would seem to possess advantages. For then we might hope, through a study of the machinery, to trace the connections between buttons and levers, find the combinations that produce the ultimately inevitable responses, and thus be in a position, as certain recent writers suggest, to *control* human nature. But any such hope is surely over-optimistic. The ethical outlook which it suggests, moreover, is not a vision of unmitigated beauty.

Such theories can scarcely arise if careful consideration is given to the physiological aspects of attentive behavior.

Selective Response.—We may begin our consideration of the peculiarities of attentive behavior with what has been called the "temporary reflex," of which the simple reaction experiment offers a good example. In this experiment the subject is set to respond to a signal by pressing a key. The signal arrives, the eye is stimulated, the finger moves. So far the action would seem to be purely reflex in character. There is a direct transference of nerve energy from sense organ to muscle, over an open path.

But how does the pathway come to be open? Nature has not created it. It is not an inherited sensori-motor arc. We are not ordinarily given to depressing keys or making motions with the fingers when (for example) red lights are seen. The sensori-motor arc in this case was built to order for the occasion. It is constructed by the act of attention required in receiving the instructions and preparing for the response.

Attentive consciousness has somehow or other reached down into the nervous system, selected a certain train of sensory elements, connected them up with a selected train of motor elements, and held them together and open awaiting the anticipated signal. When the reaction does occur it has all the outward appearance of a mechanical response. "The reaction whose time is measured," says James, "is, in short, *a reflex pure and simple, and not a psychic act.* A foregoing psychic condition is, it is true, a pre-requisite for this reflex action. The preparation of the attention and volition; the expectation of the signal and the readiness of the hand to move, the instant it shall come; the nervous tension in which the subject waits, are all conditions of the formation in him for the time being of a new path or arc of reflex discharge. The tract from the sense-organ which receives the stimulus, into the motor-center which discharges the reaction, is already tingling with premonitory innervation, is raised to such a pitch of heightened irritability by the expectant attention, that the signal is instantaneously sufficient to cause the over-flow. No other tract of the nervous sysem is, at the moment, in this hair-trigger condition. The consequence is that one sometimes responds to the *wrong* signal, especially if it be an impression of the same *kind* with the signal we expect.'' Internally, then, the temporary reflex differs from the fixed reflex in that it is constructed for the occasion, and that *the response is under way* before the stimulus arrives.

The simple reaction experiment furnishes a convenient key to the character of all attentive consciousness. Whenever and wherever it acts attention is at this work of preparing to meet a situation by constructing temporary reflexes (or sometimes more complicated nervous structures) to suit the needs of the occasion. **This characteristic of attentive activity constitutes a differential which sets it off sharply from all mechanical forms of reaction.** ''In a reflex act,'' says Bode, ''we may suppose that the stimulus which evokes the first stage in the response is like the first in a row of upstanding bricks, which in falling knocks down another. That is, the reflex arc is built up by agencies that are quite independent of the subsequent act. The arc is all set up and ready for use by the time the reflex appears upon the scene. In the case of conscious activity, on the other hand, we find a very different state of affairs. The arc is not first constructed and then used, but is constructed as the act proceeds; and this progressive organization is, in the end, what is meant by conscious behavior.''

It is precisely as if some ''Ego'' resides in the central nervous processes; an "Ego" that searches about among the organism's store of reaction complexes when it is confronted by a difficulty that cannot be met in a habitual way. As soon as it finds a combination that will suffice, the required adjustment is fully effected. It is this circumstance that gives plausibility to the "soul theory" in modern psychology. All proceeds as if attention were a distinct agency which had its seat in the brain and controlled from that vantage point the synapse switches of the association system. It is by an argument based on these rather obvious facts that Dr. McDougall (see his interesting book, *Mind and Body*) manages to establish his Animistic Hypothesis and thus escape the consequences of a mechanistic physiology. But the animistic theory, with its abstract soul, can never prove very satisfactory. Dr. McDougall would have no need for it did he not first read all plasticity and variability out of the nervous system by his mechanical concepts, as so many others have done. His "soul" is, in fact, nothing but the ghost of the nervous system's spontaneity, now reduced to abstract form, but still essential to the telling of the whole story of our concrete living processes.

The Physiological Individual.—If we are to escape this abstractness we must learn to think in terms of the concrete individual, and of wholes rather than of parts. We must strive to understand, in reference to our present problem, how paths of nervous conduction can be formed (as they are in attentive acts) by the integrative action of the organism itself. We are asked to conceive how the concrete individual man may be capable of anticipation, of selection, of problem-solving activities. The task is not so difficult as might appear, once we succeed in ridding ourselves of certain established prejudices.

It is surely not difficult to see that the individual man, in spite of his diverse aspects, is somehow one and a unity, and that this living whole is self-maintaining. An organism has this fundamental characteristic, that all of its parts are "ends and means" in turn, acting by and through one another, true members of an individual whole. Not only does man have this organic structure, as Dr. Kantor has been reminding us of late, but this individuated whole is a moving and adaptable coördination which never remains fixed, but is forever changing its internal balance. A *fixed* organism could never maintain itself amid the world's changes.

Human coördination is constantly on the teeter, forever undergoing strain and recovery. This tendency to unbalance is, of course, a direct consequence of the plasticity of the nervous system itself, and had we no means of recovering our coördination in critical situations sanity would soon be lost. But we do find that in attentive activity new nervous connections are in course of construction; that the organism is acting, somehow, to effect new adjustments and thus to maintain itself as an effectively integrated whole of thought and action.

It is a familiar theory that the attentive activities come into play only when contrary tendencies are aroused by one and the same stimulus, so that a conflict is set up which results in a state of stress and strain, a tendency to disorganization. Thus Herrick: "The rapid preformed automatisms fail to give relief, or perhaps the situation presents so many complex sensory excitations as to cause mutual interference and inhibition of all reaction. There is a stasis in the subcortical centers. Meanwhile the higher neural resistance of the cortical pathways has been overcome by summation of stimuli and the cortex is excited to function. Here is a mechanism adapted, not for a limited number of predetermined and immediate responses, but for a very great range of combination of the afferent impressions with each other and with memory vestiges of previous reactions and a very large range of possible modes of response to any given set of afferent impressions. By a process of trial and error, perhaps, the elements necessary to effect the adaptive response may be assembled and the problem solved.'' In any attentive situation there is present a state of stress and strain in the nervous system, which very stress and strain give rise *in turn* to a selecting, coördinating, integrating movement of the organism as a whole. The process is not, in its general aspects, unlike that by which tissues and injured organs are repaired, except that it is, of course, infinitely more complex.

What we commonly call attention, then, is this equilibrium-maintaining process as it shows itself to external observation. It is the inner process of adjustment as revealed in sensory concentration, exploratory movements, observational activities of all kinds, whose obvious effect is to prepare for adequate reaction to the perplexing object. In a word, attention is the outer and most obvious aspect of the conscious process, with which we shall be concerned in several chapters hereafter from the point of view of its numerous other aspects.

Attention and Consciousness.—Perceiving, remembering, conceiving, reasoning, willing, are, like attention, showings of the one conscious process whose nature we are investigating. As we take these subjects up in turn, dealing with the topics, facts, theories, which are usually discussed under the several heads, we must not lose sight of the unity of conscious activity itself. *We* revolve around our subject, viewing it now in this aspect and now in that, but it is always *the same process* that is under observation.

A number of modern writers in psychology have completely identified attentive activity and the conscious process. ''But to view attention as a special act of intelligence,'' says Sir William Hamilton, ''and to distinguish it from consciousness, is utterly inept . . . we might, with equal justice, distinguish in the eye the adjustment of the pupil from the general organ of vision, as, in the mind, distinguish attention from consciousness as separate faculties.'' With this opinion we are in the closest agreement.

CHAPTER VII

PERCEPTION

> ''The merit of what you are pleased to call my philosophy lies, I think, chiefly in having called in question the common theory of ideas or images of things in the mind being the only objects of thought—a theory founded on natural prejudices, and so universally received as to be interwoven with the structure of language.''—Reid.

We spoke of sensation in a former chapter as a consciousness of difference. The brightness of the atmosphere about us at this moment is different from that of a moment ago. The consciousness of this difference at the time at which it appeared is a sensation. The course of atmospheric vibrations to which we are accustomed as we sit in our study is sharply altered, and there is, at that moment, another sensation: this one of another quality—auditory. It is the mere awareness of ''something there'' that is different from what was there a moment before. What that something is —we do not so much as have a name for it.

Perception and Image.—The *sensation*, strictly speaking, probably very rarely or never stands out alone, particularly in the experience of those who have passed beyond the stage of early infancy. For us the sudden change in brightness is *lightning* or *reflection of sunlight from a mirror* or *the clearing of a clouded, storm-brewing sky*, or what not. The sudden appearance of a difference in atmospheric vibration is *thunder* or the *crash of dishes in the pantry* or any one of many other things. In other words the moment this consciousness of difference is forced upon us through our sense organs our interpretation is ready. It may be a correct or an incorrect interpretation as determined by a later examination of the real situation. It may be incomplete, but correct as far as it goes, and awaiting supplementation and rounding out in the course of repeated experiences, or after analysis of the first in a series. For instance a complex tracing upon a paper may be interpreted in the first instance merely as lines upon a flat surface and later, and thereafter always, as a seismogram.

In each of these cases, and the like, in which an interpretation is superposed upon the sensation we have a *perception*. But it is not just one simple process that is added to another equally simple one, the sensation, to complete the perception. Interpretation is an image or a group or a series of images that carry a meaning. They may be images of any quality, visual, auditory, tactual, or any other, and they may be very vague and ill-defined; indeed they are usually so. Thus the tree-stump by the side of a lonely country road in the evening is perceived as a robber. But the lines in the desperado's face and the glint in his eye do not appear; only the figure, the carriage, the threatening mien. All this is conjured-up image that finishes off the perception—in this case an illusory one.

The imagery of which we are speaking is united to a sensory core by a rapid, often simultaneous process of association by which gaps in the series of processes that help to make up the experience are filled in. When we perceive the stately house or our friend across the way we do not see the details of architecture or of other features —certainly by no means all of them. What is needed to make up the unbroken object of perception is supplied, as we have said, by association of images. We might say, in other words, that every act of perception is, in a measure, an act of memory. We had occasion, in a recent chapter, to refer to the blind spot in the retina. Were it not for the "filling in" process we have just now described, there should be a spot in every perceived wall at which the wall does not exist; at which we can no more see it than one can see the back of one's head. And the point should shift with the wandering of our eyes. But the wall is perceived as a continuous object. And this brings us to the next point: every act of perception involves the correction of an experience: correction that is effected by remote sense experience or by the more immediate sort. We never have perceived a wall or a table-top or anything of the sort with a gap in it, wherever our eyes may rest. We have never been able to stick a finger into it nor to lose a paper clip in it. The wall and the table-top have always appeared continuous whatever intentional or unintentional tests we may have applied to it by any sensory apparatus whatsoever. This is what we mean when we say that remote sensory experiences fill in the gaps in our visual perceptions. We have said that more immediate sensory data in other instances serve the same purpose. For example, on occasion we perceive a new cavity in a tooth by the aid of actual sensations mediated through the tip of the tongue. The cavity now seems very large. Soon, however, the perception is corrected, provided in the meantime we have got a visual impression of it by aid of a mirror and tactual impressions by aid of a finger, a toothpick or what not. The first crude impression has been corrected by all these means, plus, it may be, memory images of other dental cavities with which we have had experience in the past and which, in the last analysis, were perceived as smaller than first impressions appeared to justify.

Once more, you perceive a table-top and you call it square or, at least, right angled. You do so notwithstanding the fact that the table-top cannot possibly be represented upon your retinae as a right-angled figure unless you are so situated with reference to the table that your eye is directed from above or below toward the exact center of the object. Otherwise every angle in your retinal image will be oblique. Yet you unfailingly make correction and perceive the top of the table as a square. By what means? Over and over again you have pushed tables into corners that were called square—and tables with tops that behave upon your retinae as this one does; you have had tactual experiences of their corners; you have bumped against them and all that. On the other hand you have never, or at most very rarely, dealt with a table-top that had oblique angles like the outline image upon your retinae. Of course no conscious process of correction such as we have been suggesting precedes the completion of the process of perception. In such a familiar instance as the table-top it is almost instantaneous. But we could not perceive it were it not for a mass of more or less well defined images of many qualities that represent the residua of perhaps uncounted experiences with the object of perception and its sort.

The play of imagery in perception may be more distinctly made out in relation to an object that cannot be at once distinctly perceived. For example, when one is confronted in the night-time and in the field with an object that may be a horse or a cow, a man or a tree stump, the completion of the process of perception is delayed and, if one is interested in such things, one may subsequently describe a course of imagery that appears to have a causal relationship to the end result, and many of them, at any rate, may be distinctly recognized as memory images of past experiences, some of them images of movement. When we have come before an unusual toy or tool for use in industry or manual art we perceive it, to be sure, as a toy or as a tool, but the process is not completed until we have perceived it as a toy or a tool of a particular sort or for a specific purpose. In relation to such situations as these images of movement are clear and not only so, but we proceed to supplement them by turning the object over and about, by rotating its wheels or by making gestures in the air to describe the imagined function of the thing and by sub-vocally talking about it. By all these means combined, in a difficult case, we finally succeed in making the interpretation that we have called perception.

The Experience Theory of Perception.—All that has been said, up to this point, leads to what may be called the *experience theory* of perception. In a few words it is just this: that the interpretation implied in the process of perception is impossible of achievement apart from an accumulated mass of residua of experiences. It is impossible to conceive a wild man suddenly transported from the South Seas to our city block, who can presto perceive a high-powered automobile in the street. It will be for him merely "something there"—the terms in which we described sensation. Or at most he will perceive it in the light of some crude instrument with which he has been familiar in his native island; for perception is always made in the light of experience.

As a case in point think of the following instance: two country women were standing at the county fair by a hay tedder that was on display. (This is a machine one type of which is supported upon two wheels. The wheels are geared to a cam-shaft and to this several forks are attached. As the machine is driven forward the forks in turn dip downward under the fallen hay and toss it so that the wind and sun may have better access to it and so hasten the process of "curing" the hay.) The women, to be sure, perceived the thing as a machine but difficulty came with more refined or definite perception. At last one of them said: "I know what it is; it is a potato-digger." Both observers appeared to be satisfied and they went their way. They had undoubtedly seen men digging potatoes by the aid of hand forks; perhaps they themselves had often done so too, and this was the background of experience in the light of which they perceived this strange instrument.

Development of an Act of Perception.—Perhaps this thought may receive other deserved emphasis from the examination of a hypothetical case. How does the very young child perceive what you and I call a bell and how does his perception of it grow?

Let us assume that his first contact with a bell occurs when first he is carried to the dining room table. In his experience it can be no more than "something there." But he is allowed to touch it. Now it is "something there with a clammy feel" if he were to put it into words. This is his whole experience of the day with the bell. On the following day a memory element comes into the experience when he is once more taken into the dining room and it is the same "something there with a clammy feel." Now he lifts it and adds *heft* to his small fund of experience. He causes it to tinkle and an auditory element is added. His mother rings the bell and somebody enters with toast and other things. As time goes on the child has experiences with bells of many sizes and he finds them in many different sorts of places. Some ring more loudly than others. One calls him to school another to church; still another dismisses him from school or transfers him from one room to another. Each of these experiences and more colors the normal eighteen year old's perception of a bell. If he had had but one of these contacts and no more obviously his elementary interpretation or perception of the thing would be very different from what we find it to be in our adult life.

But it must not be understood from the foregoing that it is only our *past* experience, retained and represented in our personality in the form of images, that functions in the process of perceiving. Varieties of concurrent experiences equally play a part. We are less likely to perceive an object, spontaneously at least, outside its normal setting than in it. A baseball bat and mask suspended by the side of the pulpit in church would be perceived, no doubt, by the observers, but probably not immediately, and most of them would certainly look again and again to be assured of the meaning of their experience. If the same objects were upon the wall of the gymnasium or upon the fence by the training ground everybody who knows even the merest rudiments of the game of baseball, would immediately perceive them fully. The difference between the two situations is that between the church furniture on the one side and the gymnasium furniture upon the other that enters into our visual experience simultaneously with the bat and mask. But there is more than this, to be sure. There is, as we say, the atmosphere of the two places respectively. There is the experience of a certain feeling in church and another of different quality in the gymnasium and upon the training ground. These feelings arise, in part, from the bodily attitudes we assume in the two situations and in other part from the memories that the church and gymnasium encourage. All these experiences running on simultaneously with the appearance of the bat and mask contribute their share to the perception and to the hastening or retarding of its completion.

Illusion.—In many instances these concomitant experiences overpower, so to speak, the sensory data that are gained from the direct impression of the objects of experience. Then we have what we call *illusion.* In such a case the object is sensed in a form different from what actual measurement would make it assume, and unlike the image of the object as it is outlined upon our retinae in the case of the perception of objects of vision.

This suggests the well-known proposition that in all perception there is illusion. We have already drawn attention to the fact that the table top does not appear to us in perception as it is represented upon our retinae. In other words, we do not perceive, in this case, quite what is represented to us. Once more, if two men, one stocky and the other slender, are walking together in the street, the slender one will appear the taller even though they are of the same height precisely. A book is lying upon my desk but you say it is a box. In these instances, and numberless others of the sort, what is actually there as might be determined by rigid measurement, is not quite what seems to be there. How much difference may be between the seeming and the actuality to justify one in speaking of illusion one can hardly say. There is no hard and fast line to be drawn between illusion and what we ordinarily call correct perception.

It is customary to place illusions into two groups: those peripherally aroused and those centrally aroused. But there is no altogether unqualified distinction of the sort. It is a question of emphasis. In some cases peripheral or sensory factors are the more potent causally and in others the complexes of ideas and emotions—the central factors predominate. We will try to make this clear, as we proceed, and will be confined first to illusions of peripheral cause.

Some Illusions of Primarily Peripheral Source

The Mueller-Lyer illusion will serve as a first illustration. The lines "a" and "b" in A and B are of the same length but "b" in each case seems the longer. Photographic records of the movements made by the eyes whilst they are surveying these figures undoubtedly reveal one cause for this illusion. They take a wider sweep right and left over the lower than the upper figure. The feathered ends of the apparently longer line appear to carry the eyes on in their right-left movement, whereas the recurved ends of the other line halt them abruptly. Another cause is probably in certain simultaneous associations that are aroused by the arrangement of the lines. The feather ends occasion a feeling of wide open space; the others, one of enclosed space or a narrow, restricted area. Have we not a feeling of expansion on the wide-open portico and of restriction in the confinement of the study? So it is not only in range

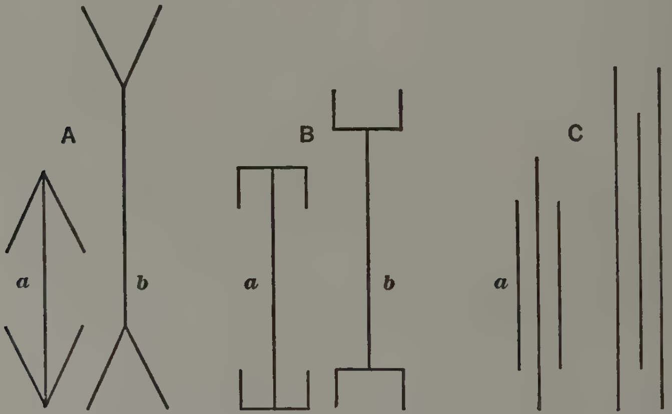
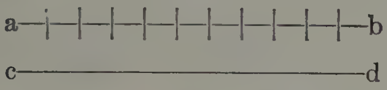


FIG. 24.—Various forms of the Mueller-Lyer illusion.

of eye movements that we find the root of this illusion. The arrangement of the lines suggests the feeling of expansion or of restriction, and simultaneously we *read these qualities into the figures.*

In C the middle lines in groups "a" and "b" are of the same length. They appear unequal because the long lines that flank the one have the effect of stretching it out; on the other side the short lines constrict it. This is a result of greater or less sweep of eye-movement.

In some cases it is apparently the relative effort involved in eye movement that is the predominant cause of the illusion. Vertical movements are more effortful than horizontal. For this reason a perfect square appears larger in the vertical than in its horizontal dimension. If an artist would create the appearance of a square, therefore, he must make the vertical dimension slightly less than the horizontal. Still another illustration of illusion due to effort in eye movement is in the figure below:



Lines a–b and c–d are of equal length. But due to the cross lines upon a–b the eye traverses it with more difficulty than c–d. Hence the former appears slightly the longer of the two.

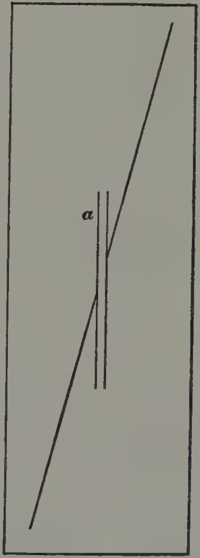


FIG. 25.—Poggendorf's illusion.

In many instances the apparent direction of a line is altered by the position or direction of other lines closely adjacent to it or intersecting it. In Figure 25, for example: the diagonal is a straight line. It appears, however, to be bent to the left or to the right according as the eyes sweep toward its middle from its lower or its upper end. Moving from below the eyes are pulled off by the vertical lines. Moving from above along the diagonal they are drawn off in the opposite direction. In each case the diagonal is carried with the deflected eye movement.

Still other illusions are traceable to our disposition to over-estimate acute angles and to underestimate obtuse angles. The so-called Zoellner and Hering illusions are cases in point. The long heavy lines in the Zoellner figure are parallel notwithstanding that they seem otherwise. In order that the acute angles in Figure 26 may seem larger than they actually are, the lighter cross lines must be shifted in their direction or the long heavy line must be inclined in one direction or the other. It is the last named adjustment that comes to pass. Perhaps this is the line of least resistance for the organism to take.

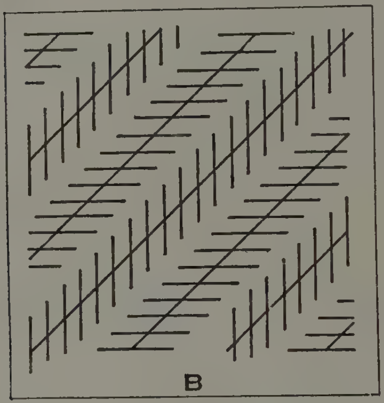


Fig. 26.—Zoellner's illusion.

In the Hering figure lines a–b and c–d are parallel; but they seem to be bent apart progressively toward their middle points respectively. In this case as in the former these lines are apparently bent slightly at each point at which they are crossed by the shorter oblique lines in conformity with a tendency to overestimate the acute angles. When the oblique lines are divergent instead of convergent toward the middle of the figure the lines a–b and c–d will bend

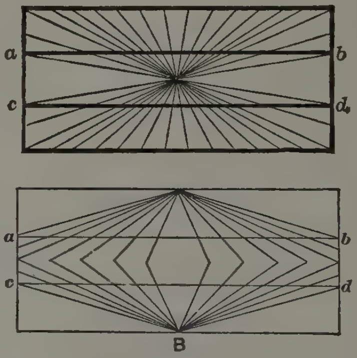


Fig. 27.—Hering's and Wundt's figures.

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[1] Titchener's Textbook of Psychology. Copyright 1910 by the Macmillan Company. Reprinted by permission.

toward each other rather than apart at their middle points.

We have been saying that in one case the optical illusion is occasioned by the relative difficulty of eye movement in one direction as compared with another; in a second case by the extent of movement and by our over-estimation of acute angles in a third case. It is not so easy, however, as it seems from these words, to set out the cause from a particular instance. Probably in every case we must resort to the fact of imperfect isolation of the important features of a figure for the fundamental cause of a given illusion. At any rate, that seems to be the situation in Figure 28.

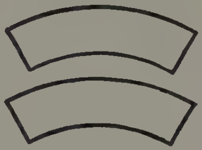
FIG. 28.

When he is asked to compare the areas represented in the figure the untutored observer invariably describes the lower as the larger. As a matter of fact they are of the same area precisely. This error is apparently due to the fact that in making our estimate we over-weight the relative lengths of those boundaries of the figures respectively that are adjacent to each other. One of these is considerably longer than the other and by an immediate inference we carry this over to the areas themselves.

The imperfect isolation of which we are speaking is one price we pay for our established habit systems. Aristotle's illusion is a clear case in point. When one's fingers are crossed as in the figure and a pencil is placed between them, there seem to be two pencils instead of but one. It is in conformity with our habitual experience to find one object when the adjacent surfaces of the index and middle fingers are simultaneously

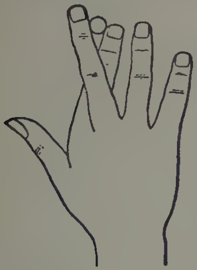
FIG. 29.—Aristotle's illusion.

stimulated, but not so when the opposite surfaces are impressed at the same time. They do not in ordinary circumstances come into contact at all. We are in the habit of finding two objects when these surfaces are touched at once and we so interpret the situation in this instance. **We imperfectly isolate the essential features of the case.**

What we have said thus far concerning optical illusions will suggest to the reader many relations in daily life. Each one can supply his own instances. The fields in which obviously they may be found are architecture; interior decoration, in which figures are employed as upon wall paper; millinery; dress-making, etc. One or a few illy chosen or badly placed lines may alter a large effect and so offend our sense of harmony.

Some Illusions of Primarily Central Origin

We said at the outset of this section on illusions that there is a group of such phenomena in which the predominant cause is of central origin. By causes of central origin we mean ideas, emotions, wishes, etc. A reference to the proof-reader's illusion will awaken distressful memories for most men and women who are accustomed to writing and publishing. If the printer in setting type has transposed two letters of a word, let us say, or has misspelled it by a little, the probability is that the author, at any rate, may overlook the error completely. Why? Because he is, as you might say, full of the ideas that he has tried to express in his writing. If those ideas are suggested clearly and in their proper sequence by the signs upon the page, as the printer has set them, everything seems right. The succession of ideas is the big thing for the author. One who is unfamiliar with the writers' argument and who cares nothing for it—still more, one who is just learning the language—is much less likely to let the transposed letters slip. In fact such a one will be the perfect proof-reader—if perfection is attainable in this relation. The forms of the words upon the proof are the big things for him.

The emotional background also is a determiner of illusions. If one is walking upon a lonely country road when darkness is coming on, particularly if one has a sum of money in one's pocket and has been stirred up by stories of robberies in lonely places, a tree-stump in the distance may appear to be a menacing robber. In other situations it would appear in the true character as the stump of a tree. To say that the observer in such a case as this was fearful at the outset is equivalent to saying that he was crowded with a sort of ill-defined imagery of acts of violence by the hand of robbers, which imagery functions in connection with the interpretation of the tree-stump impression.

An enormous variety of illusions of this type will occur to the reader. When one is eagerly awaiting in the evening the arrival of a belated home-comer for whom dinner has been delayed, the thud of the evening paper thrown against the side of the porch may be mistaken for a footfall at which the waiting members of the household are upon the point of hastening their preparations for the evening meal. Earlier in the day when the attitude of impatient expectation was lacking, no such auditory illusion could have occurred. The man of science who has for years been zealously following a research problem sees in his test tube evidence of the reaction he has been anticipating. His colleagues protest. Less eager than he, they are less subject to illusion.

All such illusions as these—and they are legion—may, in the last analysis, be understood as a case in which the observer has imperfectly isolated the essential features upon the basis of which, in colder moments, he would ground his interpretation of sensory experience.

We have described the illusion as a case in which what seems to be impressing our senses is different from what is actually there, as determined by test or by measurement. The boundary between illusion and perception it is impossible to describe. There is an element of illusion in all perception. Whether we shall call a given experience an illusion or a perception is a question of how much discrepancy we are willing to allow between seeming and reality.

Hallucinations.—If the gap is wide enough between what seems to be present before our sense organs and what is actually there we may describe the experience as a *hallucination.* So the illusion is flanked upon one side by the perception and upon the other by the hallucination. If the book upon the desk is interpreted as a box we say "*illusion.*" If it is described as an elephant, we say "*hallucination.*" If there is nothing whatever upon the desk so far as our ordinary methods of observation prove, we say again, *hallucination.* There is no defining the boundary here between illusion and hallucination.

In relation to hallucinations as well as to illusions there are peripheral and central factors, but perhaps neither of these is exclusively operative in any instance. Dr. Störring has described a case of visual hallucination that is instructive. The patient, a woman, complained that when both her eyes were open or when the left one alone was open she continuously saw Satan in her left field of vision. On examination an opaque spot was found in the lens of her left eye in such a position that it cast a shadow upon the right or nasal portion of the retina. This, as we shall learn in the course of our study of the visual perception of space —direction in particular—would suggest the presence of an object in the left field of vision. Most of us who wear glasses have now and again had an analogous experience. When a fleck of dust becomes attached to one of the lenses for a moment or so, we seem to see an object in the distance, and in a direction that is determined by the portion of the retina that is stimulated by the shadow of the obstruction upon the lens. Most of us have perhaps gone so far as to make an interpretation of the apparent object, or in the language of this chapter, to *perceive* it. But we soon discover our error and thereafter we neglect the retinal stimulation entirely. Dr. Störring's patient, however, could not neglect the disturbance. She was unusually fearful of Satan, and that he might claim her as his own. She was suffering from a psychosis: an incipient mental disease. This case illustrates the coöperation of a peripheral factor—the condition in the eye—and a central factor—the emotional state.

Dreams.—Ordinarily the term "hallucination" implies a mental disorder. The most striking illustration of the phenomena are undoubtedly symptoms of a disordered mind but normal persons suffer and enjoy hallucinations also. Our dreams belong to this class of phenomena. We have supported the theory that perceptions in general rest upon the residua of the experiences the individual has had with his world and that their form is affected at the same time by the experience of the moment and by the mental state and content that prevail at the time. The same is true of the dream. It is a reflection, in other words, of one's nature, chiefly of one's acquired nature. To be sure it is often bizarre beyond the limits of the phenomena of daily life. We have never seen a seven-headed calf—except in our dreams. Only in our dreams have we ever fought the battles of the Civil War. But we have over and over again seen calves, each with one head. We have countless times found ourselves upon one side of a wall, whereas a moment before we were upon the other side, and we have read the stories of Civil War battles, have been thrilled by the tales of veterans and have been fascinated by pictures of contending armies. We have, therefore, had a deal of experience at first or second hand out of which the most extravagant dream images may be created: a calf, for instance, with seven or with twenty-five heads.

A sensory disturbance or an emotional tension must be assumed as a starting point. If a cup of water be thrown upon the feet of a sleeper he may dream that he is wading in rushing water. If he has been thrilled by a story of personal adventures he may dream of a battle in the loft of his barn. It is easy enough to conceive of the setting off. The development of the dream imagery is more difficult. In attempting to account for it we are compelled to think of habit systems broken in pieces or dissociated. While we are awake and lying upon our couch, if cold water be thrown upon our feet our habit systems, intact, forbid us to imagine that we are wading. The sense of utter inconsistency between wading and lying upon our couch is a function of a habit system. The couch is associated with passivity rather than with actively going about in a current of water and this association or habit refuses to break in pieces.

Our interpretation of dream states will suffice for most instances at least. Miss Washburn has recently proposed a theory that covers the usual phenomena and that is in accord with the situations we have been describing. If sleep is an attitude of complete muscular relaxation we have, to begin with, an explanation of the unconsciousness of perfect sleep; for consciousness is dependent upon muscular tonicity. Now dreams occur in imperfect sleep; that is, in states of incomplete relaxation. In such a condition stimulations from without the organism and from within it may set off parts of the motor system that are in a state of tonicity or tension. Here is the basis of dreams. The ground-work is motor. The fragmentary character of these systems, free as they are from the coördinating control of supreme nervous centers, accounts for the incoherence and the bizarre nature of dreams. During alterations in the depth of sleep (or in the extent of muscular relaxation) tentative movements that belong to disconnected systems are aroused. They interfere with one another and modify one another. Accordingly dream imagery may be more extravagant than the tale of a buccaneer.

But dreams are not always incoherent. They are sometimes linked up as systematically as a treatise with our waking thought even in intimate details. Who has not heard of the solution of a troublesome problem in a dream state and of aid in the construction of stories from the consecutive imagery of dreams?

As to the solution of problems: Dr. Herman Hilprecht, distinguished archaeologist, reports that on one day when he had wearied himself from long-continued and fruitless efforts to decipher two fragments of agate that were supposed to have come from the finger ring of some Babylonian, he could say little more than that they belonged to a certain period of Babylonian history. He had ascribed one fragment, by reason of certain signs, to King Kurigalzue; the other he described as unclassifiable. About midnight on that day he retired and was soon dreaming. An old pre-Christian priest led him into a room where scraps of agate lay upon the floor. Here he told the dreamer that the two puzzling pieces of agate belonged together and that they were not from a finger ring.

The priest then explained that King Kurigalzue once sent to the temple of Bel an inscribed cylinder of agate together with other articles. The priests were then suddenly commanded to make of agate a pair of ear-rings for the god Ninib. But there was no agate at hand in the form of raw material. In dismay the priests cut the inscribed cylinder into three parts. There were thus three rings and each contained a part of the inscription. Two of them became ear-rings for the statue of the god. The fragments that Dr. Hilprecht had, he was told, were parts of them. If he would fit them together the inscription would furnish confirmation. But the third ring, he was assured, would never be found.

On the following morning Dr. Hilprecht reëxamined the fragments and found verification of the dream-story. If he could have introspectively reconstructed in detail his experiences of the weeks past; and if he could have held his reconstruction before him for careful perusal, he would no doubt have found in it that the phrases of his dream—or their meaning at any rate—had already, again and again, been eagerly entertained by him while he was hypothesizing upon the nature of the fragments. The striking thing about the incident is that the elements came forward connectedly in the dream state and that Dr. Hilprecht was moved thereby to examine the fragments anew in the light of the hypotheses he had already, presumably, passed in review. In the light of our theory we must assume that in the course of his sleep Dr. Hilprecht's motor tensions did not entirely let down at any point. There were no complete dissociations in the system, and consequently he dreamed a connected series of images.

Some of the presumed evidences for communication with the dead and with the dying belong in this category of hallucination. For example the following story has been used by Sir Oliver Lodge to substantiate his hypothesis of communication over great distance with the dying:

An English woman had a son who was a sailor. For an unusually long time she had not heard from him. He was then upon the Pacific Ocean. One night the mother had an apparition of her son standing in dripping clothes by her bedside. She awoke, aroused the family, and told them that her son had been drowned. She believed implicitly that her conclusion was true. Months later there was this much verification: the son appeared at home and on being told of the apparition he reported that it was just at that time when he fell from the crow's nest into the water. When finally he was drawn upon shipboard it was a long time before he recovered and his mates thought he was dead. Such is the evidence for a particular alleged communication through a distance with one who was said to be on the verge of death. But the safer hypothesis is that the woman's apparition is a hallucination that is subject to the same laws as hallucinations in general. During many months the woman had been under emotional tension because her son had not been heard from. Images of his drowning she had undoubtedly conjured up in her mind very frequently. In her sleep therefore when the distracting duties of the day are in abeyance and when the inhibitions that commonly prevail are thrown off; when habit systems are dissociated, the residua, so to speak, of these imaginings and emotional tensions push forward and find expression in the hallucinatory experience. The alleged confirmation of the interpretation of the apparition is not a convincing argument. There are too many possibilities involved: of coincidence, of failure on the part of the sailor boy to take account of difference in time between mid-Pacific and mid-England and of a probable disposition on the part of the returning sailor to tell a good story.

PERCEPTION OF SPACE

The act of perceiving the relations of distance, direction and area, that is, spatial dimension, is one of interpreting various sensory signs. We will set out by attending to the perception of these relations by aid of the visual organs, and first of all to the relation of distance.

Convergence and Distance.—In near vision the eyes must converge upon each other sharply in order that the image of the object may be cast definitely upon the spot of clear vision, the fovea, in each retina. To accomplish this the muscles that are attached to the external wall of the eye must do some work, especially the internal rectus in each

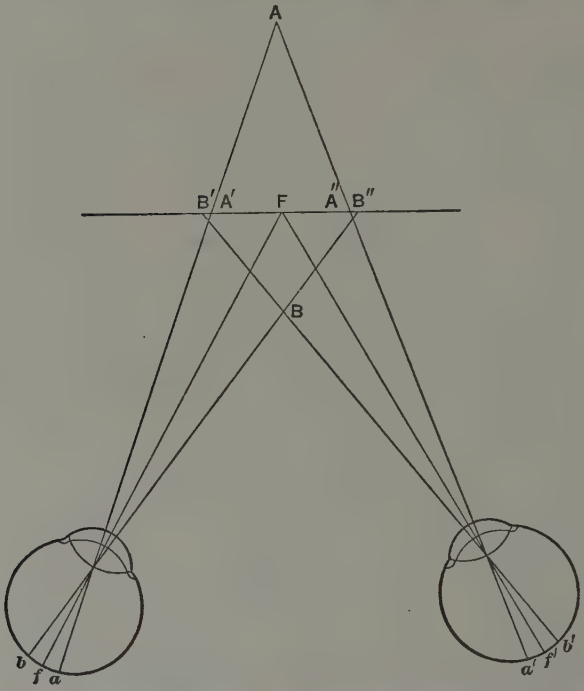

Fig. 30.—To illustrate crossed and uncrossed images. F is the fixation point and is seen singly. An image of a more distant point A falls upon points *a* and *a′* on the retinas, which are non-corresponding. As excitations of the retina are projected to the plane of the fixation point, they are seen at A′ and A″ and are therefore uncrossed, the image seen with the right eye is seen to the right of the fixation point and to the right of the image seen with the left eye. Objects nearer than the fixation point, as B, will also be projected to the fixation plane at B′ and B″ and so are crossed, the image on the right retina is seen as if it were to the left of the fixation point and *vice versa.*[1]

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[1] Pillsbury's Fundamentals of Psychology. Copyright 1922 by The Macmillan Company. Reprinted by permission.

orbit. The external and the superior and inferior recti and the oblique muscles must be in relaxation. The eyes are then converged upon each other and the attending strain of convergence is a sign of nearness. When now the object of attention is very far removed, the eyes must take such a position in their sockets that their axes may be approximately parallel because the rays of light that are reflected from the object into the eye are in this case almost parallel rather than sharply divergent as in the case of attention to a near object. When the axes are parallel the recti and the oblique muscles attached to the eyeball are all in a state of relaxation; and this relief from strain is a sign of distance. Clearly then the relative distance of two objects may be determined by alternately fixing the nearer and the farther. The alternating sense of strain and relaxation or the varying intensity of strain serves as a standard for the interpretation of distance.

To be sure, it must always be borne strictly in mind that neither in this relation nor in any other that may be referred to in the discussion that follows, is there strictly a *conscious* use of these signs. We never sit down and say to ourselves that there is so much strain of convergence and that therefore the distance must be so great. The strain sensation is ordinarily below the threshold of consciousness but it is none the less effective. That this association of muscle strain of convergence with the perception of distance is not mere hypothesis may be easily demonstrated. If, for example, the ocular recti be paralyzed by the application of a suitable drug so that they continue, despite stimulation, in a state of relaxation, all objects seem to be far away until, at any rate, other criteria shall have been substituted for that of muscle strain.

Furthermore, and this is a more familiar illustration, every experience of looking at a photograph through a stereoscope is a demonstration of the association between relaxation and the perception of distance. The picture as a whole seems removed from us as if we were looking at it from afar. And the reason for it is obvious once we have observed that the lenses in the stereoscope are so constructed that the rays of light from the respective photographs enter the right and left eyes in approximately parallel lines. The eye muscles are therefore relaxed and we have a sign of distance rather than of nearness.

All of the foregoing relates to the perception of distance in binocular vision. But we are aided by muscle strain also in monocular vision. It has already been pointed out (*supra* p. 89 f.) that the lens in each eye coöperates in vision by becoming adjusted to near and far objects. When our attention is directed to an object close to the eye the lens must become considerably convex on the front surface in order that light may be brought to a distinct focus upon the retina. In other circumstances the lens must be flattened. These adjustments are produced by the activity of the circular ciliary muscle. By the inner ends of the fibers it is attached to the forward or inner edge of the suspensory ligament in which the lens is held in position as a man's watch might be held by a broad rubber band around its circumference. If this hypothetical band be so placed that the greater portion of its width extends over the front of the watch, it will the more closely simulate the suspensory ligament. If we imagine elastic fibers attached to the forward to a greater or a less degree conditioned by the forward edges of this band and radiating outward from the center of the watch we will have a good picture representing the function of the ciliary muscle operating upon the suspensory ligament. When the muscle contracts the ligament is lifted upward: its compression is removed from the lens, and the latter, because it is elastic, bulges forward to a greater or a less degree conditioned by the amount of pull that the muscle brings into play. Having become convex in this manner the lens is adapted to near vision.

On the other hand when the ciliary muscle relaxes the lens is flattened and adjustment is for far vision. The amount of pull or strain or the degree of relaxation in this case, is a second criterion of distance. Let this muscle be paralyzed as an incident in the course of optical medical examination, or otherwise (and this occurs occasionally in the history of most individuals), and our capacity for estimating the distance of near objects is sharply diminished during the interval of the paralysis.

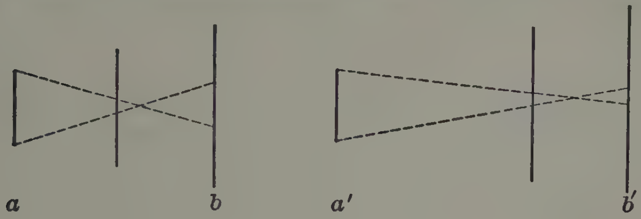


Fig. 31.

Scheme showing size of retinal image dependent upon distance of object. a and a' = object; b and b' = retina and image.

It must not be inferred that the distance-perception function of the ciliary muscle is limited to monocular vision. In binocular vision the ciliary coöperates with the muscles of convergence.

Retinal Image.—The rays of light reflected from a near object produce a large image upon the retina. The same object, as it is removed farther and farther away, makes a progressively smaller image.

The size of the retinal image is associated with the apparent size of objects, and the smaller the apparent size the greater is the estimated distance.

Double Images and Non-Corresponding Retinal Areas

The foregoing are illustrations of the visual perception of distance in which a physiological factor appears to predominate. We will mention one more that belongs in the same category. When the eyes are fixed upon a near object there is a tendency for a farther one in the line of fixation (that is in a straight line from a point midway between the eyes of the observer and extending through the nearer object) to appear double. If two pencils, for example, be held in a vertical position, one in the left hand and the other in the right, and both of them in the line of vision, the one that is being looked at directly will appear single and the other double. This appearance is especially distinct if the nearer object is fixated. (See Fig. 32.) The greater the distance between the two pencils, the more distinct will the doubling be. When the eyes are fixed upon the nearer object the rays of light reflected from it into the eyes are focused upon a line that passes through the spot of clearest vision in the retinae to which reference has already been made. The light from the farther object then will fall upon the inner or nasal half of each retina. These are non-corresponding areas. Ordinarily when the inner halves of the retinae are being simultaneously stimulated there are actually two objects present. Consequently when one and the same object is stimulating such non-corresponding areas, we have the appearance of two objects. The situation is analogous to the one that produces the Aristotelian illusion. When both eyes are fixed upon the farther of the two objects the light reflected from the nearer one

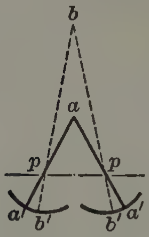


FIG. 32. — Binocular double imagery. a, b = two pencils in line of vision. a', a' = foveal; b' b' = nasal-ward retinal areas. p p = pupils.

will fall upon the outer or temporal halves of the retinae respectively. This object will then appear as two.

The amount of the tendency toward doubling, in other words the degree of non-correspondence of retinal areas that are stimulated by the object not fixated, is a criterion of the relative distance of the two objects from the eyes.

A convenient demonstration of the relations we are considering may be afforded by aid of the stereoscope. Suppose we have a card on which letters and spacing like those below are reproduced.

a   b | ab

In the stereoscope "b" will appear near to the observer and "a" far away. If, on the other hand, the spacing of the letters is arranged as below "b" will appear to be far away and "a" nearer.

ab | ab

The effect may be increased or decreased within limits by magnifying or diminishing the wide spaces in the figures above—in other words by altering the degree of non-correspondence (and consequently the tendency toward doubling) of the parts of the retinae that are stimulated by the letters respectively.

This doubling tendency is not always apparent. Indeed we are not ordinarily conscious of it at all. When one stands before an audience and turns one's eyes upon a person on the front row of seats the conditions are present for the doubling of those who are seated directly behind in successive rows. These persons do not appear as two, however, because we have learned to neglect the phenomenon. We will have occasion later to revert to the double image phenomenon and its bearing upon apparent distance when we come to consider the visual perception of objects as three dimensional or solid.

In the foregoing paragraphs we have discussed the predominantly physiological criteria of distance perception. Other criteria are preeminently psychological.

Effect of Haze.—A hazy object gives the impression of distance. The superposition of a small object upon a larger one so that the latter is hidden from view means that the large one is relatively far away. For example when one is looking at a distant barn and a man moving across the field of vision comes into such a position that he completely obstructs our view of the building, it at once seems to be very far away. How could it be near when so small an object as a man's body can hide a barn? Mountains and hills and forests at a great distance are covered with a bluish haze. Consequently blue objects nearer at hand have the appearance of more distant ones. When we are riding upon a railway car the telegraph poles by the right of way apparently move very rapidly in the opposite direction. But similar poles and trees as seen upon the other side of the field seem to move slowly backward. The less rapid is this seeming movement the greater is the estimated distance. In all these cases the perception of distance depends upon a simultaneous association and this, in its turn, of course, is made possible by a multitude of contacts that we have had from time to time with the distance experience. We may number the sands of the sea-shore but these contacts defy counting.

Position.—Perception of the position or direction of an object depends, like apparent doubling, upon the location of the points on the retinal surfaces respectively on which the image of the object is cast. It has already been pointed out that the eyes automatically turn toward whatever is the object of attention so that light reflected from it into the eyes falls upon the foveae. When the eyes are adjusted in this manner, if light rays reflected from another object reach the retinae on the right of the foveae, that is on the nasal half of the left retina and on the temporal half of the right retina, we perceive the position of that object as on our left. We have always found it to be so in our experience with the localization of objects in space and we have acquired a habit by virtue of which we reach with a very high degree of accuracy to the direction or position of an object once one or another retinal point is stimulated. It is customary to say in this connection that the stimulation of each very small area produces a characteristic *local sign.*

A rather striking illustration of the determination of position in space by the locus of retinal stimulation is afforded by aid of a card on which the illustration below is reproduced:

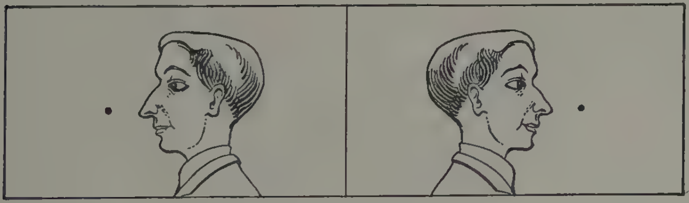


FIG. 33.

Observe this card through the lenses of a stereoscope and the two figures upon the card appear to come face to face. This is for the reason that the eyes are directed toward the central points upon the right and left sections of the card respectively; the figure on the right end is represented only upon the right or temporal half of the right retina. But this retinal area is customarily stimulated by an object upon the left. Hence we see the right hand figure as if it were upon the left. The converse is the situation as respects the left hand figure. The effect is heightened by reason of the structure of the stereoscope which prevents light rays reflected from the right from entering the left eye and *vice versa.* The phenomena we are describing here can be observed without the stereoscope, though less satisfactorily, if one will direct one's eye toward the central point on the sections of the card respectively.

Area.—We perceive area by aid of vision. One of the most important criteria in this connection is the amount of eye movement that is involved in surveying the given area.

But the most complicated, and in many respects the most interesting, problem in visual space perception is that of three dimensions, or of solid objects.

Perception of Solids.—Our two eyes obtain two different pictures of whatever object we may be looking at. If we hold up a book before our eyes so that the shelf-back is squarely toward the face, we can see, with both eyes open, the two covers of the book with equal distinctness and the shelf-back stands out clearly. Close the left eye. The shelf-back and the right hand cover alone are in full view. Close the right eye and the left cover comes into view with the shelf-back. Each eye affords its own picture of the same object, because it stands at its own angle with reference to it. There is a common element: in this case, the shelf-back. It is probable that, if we had been deprived of sight until now and were suddenly to acquire the visual function we should see every object as two until we should build up so close an association of them as to amount to a fusion of the pictures and consequent interpretation of singleness in the object.

Every stereoscopic photograph is analogous to the twofold retinal picture of an object of vision. Here we have two photographs, in fact, made by two cameras standing side by side. The object is represented upon their sensitive plates from two different angles. Take, for instance, the card below: measure, on the right hand the distance

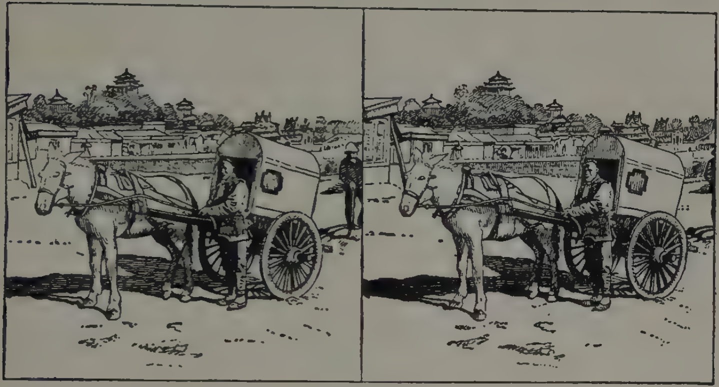


FIG. 34.

between any two points on the illustration. Measure also the distance between the corresponding points on the left. The two distances are unequal; and this is for

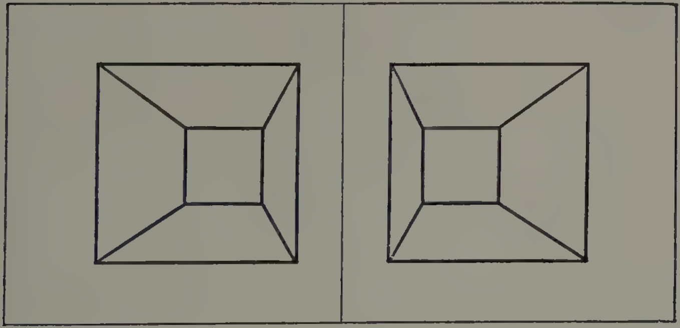


FIG. 35.

the reason that when the two cameras are directly before the object the one on the right sees farther around the donkey's left ear, for example, than does the left hand camera. Any other two corresponding points are at different distances apart on the right and left. Because we have "two eyes for to see with" we *see around* corners.

The same situation holds for Figure 35. The truncated pyramid stands out as a solid when it is seen in the stereoscope because of the slight disparity between the right and left hand images.

On the other hand if corresponding distances were equal on the right and left in Figures 34 and 35 there would be no appearance of solidity. The case would be like looking at the object with one eye alone.

The proper arrangement of light and shade, too, aids in producing the effect of solidity as shown in Figure 36.

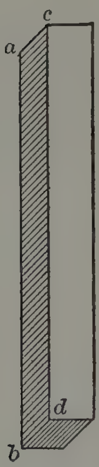


FIG. 36.—Shading makes line *a—b* seem farther away than *c—d*.

Auditory Perception. — The auditory perception of space is precarious. The direction of sounding objects whether to the right or left can be perceived with fair accuracy. This is probably due to relative intensity of stimulation upon the two ears. If a tuning fork or a non-periodically vibrating object is upon one's right, stimulation of the right ear is more intense than of the left. It is possible, too, that a given tonal vibration reaches the ears respectively in different phases and that this offers a criterion of direction. Front and rear directions are less easily distinguished. This applies especially to tones. With respect to them the subject's report of direction is scarcely better than a guess, for if two forks of the same vibration rate are vibrating simultaneously, both in front and behind, and one of them be stopped, the subject's judgment as to which one is continuing will be right in hardly more than 50 per cent of a series of trials. Perception is slightly more accurate when the stimulus is a noise or a tone rich in overtones. This suggests that some of the components may be modified more than others when they reach the meatus and that such modification offers a clue.

Distance is guaged in auditory perception in terms of intensity of stimulation as compared with the same quality from a sounding body at a known distance.

Undoubtedly necessity in this relation as in others is the mother of invention; or rather it stimulates attention to signs of direction and position, and therefore leads to the development of habits of interpretation to which otherwise we should all be strangers. This is particularly evident amongst the blind whose means of spatial perception are sharply curtailed. Their skill in guiding themselves around obstructions occasions surprise amongst seeing people. There can be no doubt that they have an advantage in certain auditory habits. The authors have observed totally blind subjects who can invariably report correctly that a 3 x 5 inch card is on the right or left when it is held in position two inches now from one cheek and now from the other. The only workable hypothesis in this relation is that when the card is brought into position it alters by a little the behavior of sound waves that are impinging upon the adjacent ear. One of these subjects, in moments of doubt has the habit of clicking his lip now on one side and again on the other. After such a performance he invariably reports correctly. When his ears are filled with cotton batting his accuracy is sharply reduced. Such observations as this lend support to the hypothesis we have mentioned and incidentally they provoke a degree of confidence that we have but scratched the surface of the possibility for distinguishing differences through our organs of sense.

Tactual Perception.—By means of touch, we arrive at the perception of space in three dimensions. But it is only with reference to objects that directly stimulate the touch organs in the skin that we obtain tactual perceptions of space relations. Within this narrow sphere we become extraordinarily acute in the localization of objects. Generally speaking, those portions of the skin that are ordinarily uncovered by clothing are the more accurately useful in this relation and different portions of the exposed skin are greatly variant in this respect. Close your eyes whilst your companion touches your wrist with the point of a pencil and, without opening them, attempt an instant later to touch the same spot with your own pencil. In such a case errors of one centimeter, approximately, will be the rule; but on the tips of the fingers and the palm of the hand, on the lips and cheeks and forehead the error in such a test will be very much smaller. Tactual localization, therefore, is not absolute. It is relative to the area that is under stimulation.

Our accuracy in this respect has given rise to the theory of local sign: that is, that each point upon the skin when stimulated occasions a quality of sensation that is somewhat different from that which is occasioned by the excitation of any other point. It is this local sign that guides the movement of the subject's hand toward the stimulated point. Localization is more accurate where nerve endings are numerous. There is, too, the motor theory of tactual space perception. Stimulation awakens a tendency to move a hand toward the excited point on the skin. One who is asleep will unconsciously react in this manner, though not so accurately as a waking person, and the relative inaccuracy of the performance is indication that the motor theory does not fully account for what is going on. Finally, the association theory: often a visual image of the point touched comes forward immediately upon contact and this is assumed to play a part in the process of localization. Obviously no one of these theories is sufficient in itself. No doubt all these factors work together in the perception of tactual space.

The perception of distance between two points on the skin involves their localization and, apparently, a kinaesthetic or motor image of a going-across or a pulling-over from one point to the other. It is closely associated with the problem of the "limen of two-ness." What is the least distance between two points upon the skin that is consistent with the clear distinction of two points. It varies from one mm. on the finger tips and on the tip of the tongue to from 40 to 60 mm. on the middle of the back. But these values may be sharply reduced by practice. Outside the laboratory the salesman of silks and satins and other textiles develops extraordinary skill in the detection of qualities of goods by tactual impression, and in-so-far as distinction involves a comparison of the smoothness of surfaces it is a perception of distances between or among points.

The perception of the area of a surface by tactile impression, without involvement of bodily movement reduces to the simultaneous stimulation of innumerable points and to the "feeling" of a complicated network of distances and directions.

It is perhaps not strictly true that we perceive the third dimension by means of tactual impressions. To be sure we may gain a fairly accurate idea of the three dimensions of a solid by grasping it in the hand, but in this case the flexion of the joints is involved.

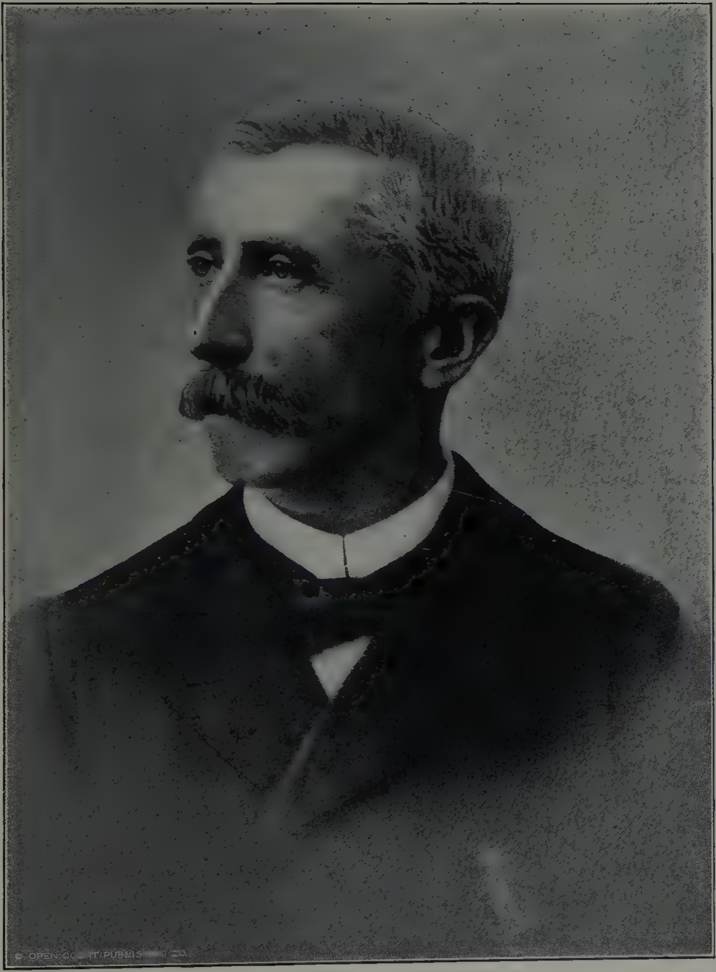
Motor Space.—The perception of distance by means of the kinaesthetic or motor sense involves flexion of movable parts of the body. Whilst the eyes are closed if one move one's arm over a given distance, from one post in a graduated bar to another, and, next, having removed the farther post, attempt to repeat the movement exactly, one will make no great error. After extended practice in one case in which the distance between posts was 75 cm. the error was reduced to approximately 4 cm. and the subject was probably capable of still finer adjustment with additional training.

We have now summarized the outstanding phenomena of space perception. Other sense organs than those we have mentioned make their small contribution in their own way, not always directly. Odors, for instance, by their faintness or intensity are associated respectively with great distance and with nearness. Taste and temperature, pain and pressure contribute, at least—as does every other sense organ—to the perception of a place within or upon the body.

Perception of Time.—There is no definite time stimulus. The perception of time is that of the succession of events, and these events may be brought to our awareness through any department of sense whatsoever.

What is the least possible perceptible interval of time will depend upon what organ is stimulated. If it is the ear the interval between auditory stimuli must be at least 0.002 sec. If it is the eye that is stimulated, it must be at least 0.044 sec. But if both of these organs are stimulated simultaneously the time between impressions must be extended to approximately 0.16 sec. in order to be perceptible. Very short intervals such as these and longer ones to about 3 sec. duration, like those of attention or expectation, are perceived by the criteria of inward strains. When such intervals are unfilled by events they seem short probably because the tensions that normally occasion the sense of strain have not had time to develop. If the same intervals are filled, on the other hand they seem longer; and this may be because of the strain of initial adjustment to each of the several events.

But long periods of time are perceived as short when they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TH. RIBOT

(*See p. 237*)

are crowded with events and as longer when they are empty. In the course of a long unfilled period the strain of expectation rises to a high pitch. It is offset by attention to intervening events, particularly if they are pleasurable.

Aesthetic Perception.—There are wide individual differences among people as to their capacity for perceiving the beautiful, the humorous, sublime, and the like. In these cases there is probably almost as little of definite stimulation of sense organs as in relation to the perception of time. Just what is it that awakens the percept of beauty in respect to a building, a painting, or a piece of statuary? Perhaps very little that is inherent in the beautiful object itself. In the main it probably rests in associations that have grown up in the personalities of the perceiving subjects themselves; associations that may be multiplied to any extent by contact and training. This we have seen is true of perception in any other department of human experience.

The data of experiment in relation to aesthetics are very meager, but there are some facts that stand out with considerable clearness. Even so simple an object as a rectangle or an ellipse may appear beautiful in one form and less so than in another.

It is a general rule to which there are few exceptions that such figures are most beautiful when the width is about sixty-two per cent of the length. This is known as the "golden section" and these are the relations of the cross in art, approximately.

The discussion in this chapter has brought to the fore many acts of perceiving, in each of which the process is seen as illustrating a rapid association of memory data which give the perception its quality. A bit of sensory data such as a visual or auditory or tactile impression or what not sets off the chain of associated processes.

CHAPTER VIII

MEMORY

> "That faculty of the soul which, of all others, is of the least consequence to the character, and has the least virtue or vice in its several degrees, at the same time that it admits of a great variety of degrees, is the *memory*. . . . It is so far from being a virtue to have a good memory, that men generally affect to complain of a bad one. . . ."
>
> —DAVID HUME

Retentiveness.—We have remarked elsewhere that an individual's experience is a thing of growth and development, of cumulative organization. Now mental growth, with all that it implies, depends upon two marked characteristics of the human organism: plasticity (or receptiveness) and retentiveness. In our chapter on attention we stressed the fact of human adaptability in the face of novel situations. This adaptability, we said, depends upon the receptiveness of the organism to new impressions and a capacity to utilize such new impressions in the formation of new systems of response. We must now in turn consider the retentiveness of the organism, upon which all cumulative development depends as well as our ability to profit by past experience.

In the long run we shall find ourselves concerned, not so much with retentiveness in itself, as in the results which it effects in human experience. For with respect to retentiveness *per se*, as a natural capacity of the organism, our information may be quickly exhausted. But the facts about learning, memory and habit, as observable processes, are long in the telling and of profound interest and importance.

Physical Analogies.—It has been the custom of psychologists to speak of retentiveness as a property inherent in all matter and with this thought to link up the human mnemonic capacity with the universal receptivity of bodies. "I would have you imagine then," says Plato in the *Theaetetus*, "that there exists in the mind of man a block of wax which is of different sizes in different men; harder, moister, and having more or less purity in one than another, and in some of an intermediate quality. . . . Let us say that this tablet is a gift of memory, the mother of the muses; and that when we wish to remember anything which we have seen or heard or thought in our own minds, we hold the tablet up to the perceptions and thoughts and in that material receive the impression of them as from the seal of a ring; and that we remember and know what is imprinted as long as the image lasts; but when the image is effaced, or cannot be taken, then we forget and do not know."

Physical analogies of this type are highly suggestive. Thus, if we assume that memory is a function of the brain's plasticity, we may suppose that some people have hard brains, difficult to impress, but when once impressed possessing the capacity of retaining permanently the marks thus received; and some people, we may continue, have very soft brains, easily impressed, but incapable of lasting memory. Analogies of this kind are actually employed in modern psychology. One thinks inevitably of jelly and paraffine wax!

In the beginning of modern times we find Descartes repeating the same idea, in essentials, that Plato, in one of his whimsical moods, set forth, "The traces left in the brain incline it to move the soul in the same way as before and also to recall something to the soul, just as the folds in a piece of paper or linen make it more apt to be folded again in the same way than if it had never been folded so before.'' How often have these very words been repeated, and how often this idea elaborated, in modern psychology! But such analogies will not carry us far. Our memories are not inert, wooden, passive things. We do not receive passively, nor do we retain passively. We must advance beyond these obvious crudities.

Organic Memory.—Modern theories fix definitely upon the nervous system as the seat of our retentive capacity, and in particular upon the projection areas of the cortex. What kind of modifications can be conceived to take place within the infinitely fine structures of the cortical system, and by what kind of process are they imprinted? We are driven to analogy again, in the absence of direct information. We may suppose that the transformations which occur in the nervous system, as impressions are received, are similar to changes which we observe in the grosser tissues of the body. Our organs, in Dr. Carpenter's phrase, tend to ''grow to'' the modes in which they are exercised. Thus muscles, exercised in special ways, grow to the mode in which they are exercised, and tend to retain modifications so accumulated. Have we not a complete theory of evolution worked out along this line? Thus Lamarck: ''In every animal which has not passed the term of its development, the more frequent and sustained employment of each organ strengthens this organ little by little, develops it, increases it in size, and gives it a power proportioned to the length of its employment, whereas the constant lack of use of the same organ insensibly weakens it, deteriorates it, progressively diminishes its powers, and ends by causing it to disappear.'' We might substitute the word ''memory'' for ''organ'' in this passage and have a fairly intelligible statement.

The principle of modification thus enunciated is made into a general evolutionary doctrine by supposing such acquired changes to be transmitted by inheritance. This Lamarck proposes in his fourth law. "All that has been acquired or altered in the organization of individuals during their life is preserved by generation, and transmitted to new individuals which proceed from those which have undergone these changes." Note that in Lamarck's thought modifications of the bodily tissues are produced by *exercise*, not by the sheer impact of external forces upon the organs, nor yet by chance variation. This notion we may employ in a genetic theory of memory, however little it may count nowadays in biology.

Let us assume that the nervous tissue *is* exercised, in varying and sometimes in new modes, and let us agree that it possesses an unusual tendency to become established in any mode to which it has been exercised. What are the occasions, then, in general, upon which nervous activity is aroused? The nervous system, as James reminds us, can be accidentally modified also by gross mechanical action, for it is sheathed in bone and tissue, and elaborately protected against the external forces to which other of the bodily organs are exposed. "The only impressions that can be made are through the blood, on the one hand, and through the sensory nerve-roots, on the other; and it is to the infinitely attenuated currents that pour in through these latter channels that the hemispherical cortex shows itself to be peculiarly susceptible."

The incoming nerve-currents, we have said, do not act upon a purely passive wax-tablet nervous system, but rather upon a nervous system whose chief characteristic is a capacity for plastic response. The sensory currents are the occasion for the exercise of nervous reaction. Sometimes, it may be, a current from within the cortex itself occasions some form of nervous activity. In any case the nervous system does act, sometimes in new ways, sometimes in old, but always the mode of action adopted tends by reason of such exercise to become established and confirmed by our retentive powers.

It is somewhat difficult, perhaps, to reconcile this organic notion of nervous exercise with the prevalent mechanical theories which regard neurons as nothing more than conductors of current. It is possible, however, as has been shown by a number of recent physiologists, to conceive that the synapse has a more subtle function than that of a mere automatic switch. Such a reinterpretation is specified whenever the nervous system is conceived as a truly organized whole. "Lethal," says J. R. Kantor, "is the blow dealt to all neuronic abstractions by the fundamental facts of neural physiology. No question exists at all but that the nervous system functions as a unified whole, and while the neural abstraction may be useful for experimental purposes . . . physiologists and neurologists are not insensitive to the factitious character of the neural circuits. To the writer it appears most extraordinary that psychologists who are not benefited in the slightest by neural abstractions but on the contrary are seriously hampered by them in their studies, still persist in their employment, whereas even the physiologist uses them only as convenient fictions." The facts of the mental life force us to the conclusion that the nervous system is a self-maintaining coördination or individual whole, and that its workings cannot be explained, for our purposes, in terms of the inert receptivity of neurons and synapses.

And now we have said something *about* retentivity, but our understanding of retentivity itself, as a property of the nerve substance, has not been forwarded. Some day, when the bio-chemists have penetrated more deeply than at present into the constitution of our nervous stuff, and the neurologists have determined with more precision just what takes place amid the complexities of our microscopic nerve structures, we may be able to indicate with some show of plausibility the substance and the process in which retentivity inheres.

The Four Topics.—Memory is generally discussed under four heads: Learning, Retention, Recall, and Recognition. This division of the several aspects of the memory process is of considerable practical value in enabling us to keep our thinking in order amid the mazes of a very complicated subject. It will be understood, of course, that these are not separate processes, but rather several fairly distinct views of one and the same process.

Learning has to do with the original reception of the fact to be remembered and with reaction to it, whether the learning be a *deliberate* memorizing, having further recollection in view, or a form of response which, while not thus motivated, nevertheless as a matter of fact does make future reproduction possible. We remember some things because we have learned them with the intention of remembering them, but others—are just remembered. Let us call the latter type of learning *direct* learning, merely by way of having some designation for it. Direct learning is natural and unsophisticated, whereas deliberate memorizing is a self-conscious attempt to strengthen our natural powers of retention.

Retention we have already discussed in so far as this has to do with a fundamental capacity of our nature. We have no control over our retentive powers except such as may be exercised in the learning process itself and by frequent recall of the thing or its associates. We may exercise our nervous systems in certain ways, but there our responsibility ends. Whether, in the interval between learning and recall the impressed modification is to persist, we cannot determine. Its fate rests in the laps of the Gods.

Recall has to do with the process by which a fact, learned and retained, is again made available in experience.

We may distinguish two forms of recall, *organic* and *psychical*. A great many facts merely recur, in their time and place, as naturally as breathing takes place. We give them no attention; they come and are gone and we take no more notice of them than of many a physical object which we pass by in direct action. Such memory is *organic*.

We have *psychical* recall, or memory proper, according to our conventions, when **recognition** is added to recall. To recognize the thing is to *attend* to it, and it is the presence or absence of attention that marks the fundamental difference between organic recall and psychical memory. Psychical memory, in its turn, may be either direct or deliberate, for, as we know, the remembered fact may be immediately recalled and recognized, or it may be dragged up from the stores of the past by a strenuous and planned effort.

In the present chapter we shall be concerned chiefly with psychical memory, and with learning, retention, and recall as related to psychical memory. *Organic* memory has been in part discussed in the chapter on Habit, since in men organic memory is chiefly expressed in the form of habit. We shall touch upon it here only incidentally.

Definitions of Memory.—True or psychical memory, then, is recall with recognition. But perhaps, that formula can be expressed in better English. The most widely quoted definition of memory, nowadays, is that of William James: "Memory proper, or secondary memory as it might be styled, is the knowledge of a former state of mind after it has once dropped from consciousness; or rather **it is the knowledge of an event, or fact,** of which meantime we have not been thinking, with the **additional consciousness that we have thought or experienced it before.**" There is nothing novel about James' definition except the phrasing, which *is* rather neat. Aristotle expressed the same thought over 2000 years ago. "Memory, on the other hand, regards the past. . . . For when memory actually takes place, one must say that the process in the soul is such that one formerly heard, perceived, or thought the thing. Consequently, memory is neither sensation nor conceptual thought, but it is the condition or modified form of one of these, after the lapse of time. . . . Consequently, all memory is associated with time." A definition that has endured as long as this may well be considered established. Memory proper, or *psychical* memory, is recall with attentive recognition.

Our definition makes it possible for us, in the present chapter, to limit our field of discussion to manageable dimensions. It will be observed that we have arrived, by our preliminary qualifications, at the *conscious process* once more. Perhaps we ought always to speak *of remembering,* in this connection, and never of memory, as if the subject of discussion were a mere faculty or capacity. This conscious activity, remembering, we will assume, has a function which can be understood, and it will be our aim to interpret it as a vital process. But first we must call to mind some of the salient characteristics of the memory process, and of learning, retention, and recall as conditioning eventual acts of remembering.

Learning.—In order that a fact or event be retained it is necessary that it be originally experienced. Learning has to do with the formation of nervous modifications which make eventual recollection possible. We have distinguished between *direct* and *deliberate* learning.

Any deliberate process of learning, in which we set out explicitly to commit a set of facts to memory—as in learning a list of names—presupposes a high degree of sophistication. Here we find man acting on the knowledge that his capacity to remember a set of facts in the future depends upon his present performance. Sometimes, in fact we follow a rather elaborate technique in learning, which would indicate some knowledge of the mode of operation of the retentive capacities. This involves a bit of "applied psychology." Deliberate, self-conscious learning, then, is a highly complicated process.

Most of our learning is, however, *direct* and natural. We are able to remember a host of things that we never took deliberate pains to learn. We can often remember a name heard only once; the title of a book casually mentioned; the sound of a singer's voice; the expression on the face of a friend; even though there was no *intention* to remember nor any expectation of future recollection. The items retained have somehow become caught up into the texture of our experience and held there indefinitely.

This apparently effortless learning is of the utmost significance since it constitutes the perfect type which, in deliberate learning, we can only approximate. What is deliberate learning, indeed, save a conscious attempt to reproduce the conditions under which direct learning takes place?

Learning and Interest.—The great mass of things with which we come into contact impress us momentarily and then disappear to be lost forever in the limb of forgetfulness. Learning is selective in that it fixes in memory only a few of the facts out of that great multitude that might be retained. This is particularly true of our direct learning, although deliberate memorizing is itself an expression of preference for certain facts. This being so palpably the case we ought to inquire, What things *do* we remember? What is our scheme of selection?

The answer that immediately suggests itself is that we remember those things which bear upon our interests. Suppose, for instance, that one of us is to meet a certain lawyer, named Hollywood, at the Blackstone Hotel on Wednesday afternoon, December the twenty-third, to arrange for the transfer of a large fortune left by an uncle recently deceased in Australia. There is little danger, as men go, that either the name or the appointment will be forgotten. These things touch a vital interest. Many an otherwise sane citizen, however, will forget to make a purchase for his wife even though the latter, with past experience in mind, employ all her ingenuity to impress the chore on his memory. He is not interested except, perhaps, negatively.

Generally speaking, we have no difficulty in remembering facts which are connected in any really vital way with our important concerns and lines of action. This is particularly true, of course, where the facts in question are frequently referred to or made use of, or where they form an integral part of a general scheme of action and thought. Chemical formulae do not easily escape a person for whom they constitute important unities in a general scheme of research, although they may slip from the mind of a plodding undergraduate with a celerity little less than fiendish. What we shall learn, then, depends largely upon the nature of our purposes.

This very general statement should, upon examination, reveal some important underlying considerations. Psychologists have noted, in the course of their observations, that we are most likely to remember facts (1) to which we give keen attention, (2) which are frequently experienced, (3) which impress us vividly, or (4) which arouse an emotional reaction. Let us consider these determinants of memory each in its turn.

Attention and Learning.—Attention, as we have elsewhere remarked, may be either protracted and intense or transient and casual; or it may possess any degree of seriousness between these two extremes. It is certain that not every fact attended to will be remembered. But we may say with assurance that such facts as arouse a strong attentive reaction are *most likely* to be remembered. It is impossible, in the present state of our knowledge, to speak with any assurance of the survival possibilities of such things as receive only our casual or marginal attention. In the abnormal field we often have occasion to speak of a kind of ''sub-conscious'' retention whereby facts not noted in direct consciousness are nevertheless reserved in the crypts of memory awaiting only some magic touch to bring them to light. Here, however, we are dealing with dissociated minds. The extension of this conception of sub-conscious retention to normal personality would scarcely seem warranted. The only sub-conscious memory with which we may deal here is *organic* memory. No doubt a great many items of experience not subject to *psychical* recall and recognition are organically retained, modifying present actions in ways of which we are not aware.

In general, then, only objects which have been attended to intently may be psychically recalled and not all of those. ''For a state of mind to survive in memory,'' says James, ''it must have endured for a certain length of time.'' It must endure, let us add, long enough to enable the attentive processes to penetrate the object and effect an adjustment towards it. The more complete such penetration the more likely the object is to be remembered.

Learning and Repetition.—Things which have been frequently attended to are more likely, other things being equal, to be remembered than such as have been experienced only once. A name heard three times has more chance of survival than the same name heard once; a picture studied over and over is more likely to become a permanent treasure of memory than the same picture noticed only once or twice. This is a principle well known to practical life. Teachers, advertisers, propagandists are well aware that a fact insistently repeated secures thereby an increasing survival value and a cumulative impressiveness.

Mere repetition, however, is of little consequence in itself. It is significant only in so far as it makes the fact the object of repeated acts of attention. With each succeeding presentation attention penetrates the object more thoroughly and in so doing assimilates it more completely to the individual's organized system of experience. Thus things frequently handled, considered, reckoned with as factors in actual or conceived purposive activity are, without any self-conscious intent on the part of the experient, easily, even fluently, remembered. The names of streets which we frequent or of persons with whom we deal, the number and location of familiar objects—these cause us little concern in remembrance. Mathematics which we employ, language which we use, are not likely to trouble our memories. They have become, under the analytical and synthetical operations of conscious attention, a part of the warp and woof of our experienced worlds.

Learning and Intensity.—Objects which are vividly experienced, in their original presentation, are likely to be remembered. This statement is no more than a reinforcement, to be sure, of what we have already remarked under the head of attention and learning. Our interest here, however, is in the object itself from the standpoint of the conditions under which it *becomes* intense. There is nothing, we may be sure, in the nature of an object itself—considered out of reference to human purposes—that gives it a superior power to impress itself upon the memory. But some objects do bear, as a matter of fact, more directly upon our interests than do others. Objects become vivid, then, when they promise or threaten unusual consequences; when, in relation to the general body of our plans they possess a distinctive significance. Such objects call upon us to marshal all our forces for their understanding and control.

An intense stimulus, in and by its own powers, is often unable to induce a strong attentive reaction. The merest whisper, on the other hand, may seem to shatter a man's world to fragments and call forth the most energetic response of which he is capable. Such objects are intense. They are brought into the "focus of consciousness" with unusual sharpness and reacted to with great vigor. Their intensity, then, is not intrinsic, but borrowed. They become important by reason of their significant bearing upon other facts. The most superficial observation will show that objects which are intense in this respect are not easily forgotten.

Learning and Emotion.—Any object that arouses an emotional response is likely to be remembered. This is so, whether the response be of the grosser emotional type or a sentimental reaction of more subtle character. The typically emotional response, of course, is intense, and its object vivid. Such reactions are aroused, as we are to see in another chapter, by situations that baffle us, or which for some other reason leave us temporarily out of equilibrium. Situations of this kind call forth an unusual strain of the attentive processes with corresponding depth of mnemonic impression.

The milder affective reactions may, however, be quite as effectual in fixing things in memory as our more strenuous emotional states. The halo of feeling which surrounds an object on the occasion of a sentimental reaction seems, if we may speak figuratively, to cause the object to stand out with unusual vividness against the great mass of our casual experiences; and it is always remembered with the same emotional glow. There can be no explanation of this phenomenon except that an object which thus stirs our sentiments is envisaged in relation to other objects, which have the same feeling-tone. It is joined in apprehension to some system of facts which embody a dominant purpose. Thus, upon hearing a stranger speak favorably of some leader in whose fortunes we take the greatest interest, we react with a considerable glow of feeling; the more so when the stranger himself speaks with ardor. Needless to say, the speaker gets our best attention, and neither he nor his words are likely to be soon forgotten.

All of the considerations which we have just been reviewing, then, point to interested attention as the real determinant of our learning. At least no other factor has been proposed to account for the manner in which, in direct learning, certain objects come to be fixed in memory and others dismissed, even while the senses still tingle with their after-effects.

Deliberate Learning.—Deliberate, systematic, planned memorizing is seldom required, in the normal course of life, for the retention of facts which have an immediate bearing upon our affairs. Man has discovered, however, that his powers may be increased, his range of possible actions extended, the horizon of his experience broadened, by the adoption of a deliberate technique of learning. Even the most commonplace of men, nowadays, have some smattering of "applied psychology."

The question, how far we ought to carry our attempts to acquire knowledge by memorizing, and how far, on the other hand, we ought to depend on books and files, is too complicated to be taken up here. In the main we do find that deliberate learning is employed for the retention of facts which, in their original form, have no immediate connection with our routine activities, but which are likely to be of service in some emergency. It is thus with lists of names, of articles, of figures—with dates, tables, formulae, vocabularies. Sometimes such items will be memorized with specific reference to a given occasion. At other times, of course, it is our expectation that the things now deliberately memorized may eventually become so assimilated to our scheme of things that they may remain permanent possessions; vocabularies, for instance. For the nonce, however, the facts must be carried along by brute effort, like so much excess baggage.

Modern experimental psychology has paid considerable attention to the memory process. The very nature of such experiments, of course, makes necessary a deliberate and self-conscious form of memorizing. It is appropriate, then, that the results of these experimental studies should be cited under our present topic of discussion.

Nonsense Syllables.—Ebbinghaus led experimental psychology into a highly interesting program by his invention and use of nonsense syllables. A nonsense syllable consists of three letters, a vowel flanked by two consonants: *num, giz, poy, kim,* are examples. No nonsense syllable, to be usable, can form a word with a recognized meaning. Even syllables that strongly suggest words, such as *tak, bel,* are to be avoided. The syllables provide us with facts of approximately equal *meaning value.* To be sure, we are compelled to reduce the meaning factor to zero to get this equality, but it is worth having, the experimentalists think, even at that price. And, it is believed, there are distinct advantages in a kind of material that draws the memory process into displaying its most basic forms of activity.

Meaningful material is almost certain to be of unequal significance for different people. Besides, it would be quite difficult to secure lists of common words, especially short words, which did not vary markedly in frequency of use, range of denotation, and relative general importance. Some of them, consequently, would "naturally" be more easy to learn and retain than others. Words, again, would be hard to arrange in such form that they would not suggest definite sentences that might be remembered *as* sentences. Nonsense syllables are subject to none of these disadvantages. They furnish, consequently, ready material for almost any kind of experiment in memorizing.

In his original experiments Ebbinghaus wrote his series of syllables on cards and learned them by reading from the cards in a chosen order. Later experimentalists have employed special apparatus for exposing syllables to view, in regular order, and for fixed periods of time. This provides an equal period of attention for each of the combinations presented and an equal period of relaxation between presentations. There is no objective means, of course, of guaranteeing steady and equal attention to the successive presentations, but when care is taken, by competent observers, attention can be controlled within satisfactory limits.

The Span of Memory.—It has been found that the average adult can remember a series of six or eight nonsense syllables with a single repetition. Results will vary slightly, as might be expected, with the individual and the method of presentation. The memory span (usually measured nowadays by numbers) has been found to be remarkably low for certain mental defectives and constitutes one of the important indices of mental inferiority. In young children it is quite low, increasing with years up to about the age of fourteen, when it reaches its maximum. Series of syllables which out-range the memory span, even slightly, require many repetitions for their learning, and each syllable added to a series makes it increasingly difficult. Thus it requires, according to Ebbinghaus, 13 repetitions to learn a series of ten syllables, 16.6 for 12, 44 for 24, and 55 for 36. Ward remarks that the last figure is peculiar since "At this rate the process should, as the number of syllables increases, become comparatively easier—which seems plainly absurd."

The memory span for meaningful material is, as might be expected, much greater. Eight or nine one-syllable words may be learned by one repetition (learned, that is, to the point where they may be repeated once without error) and as many as 10 or 12 one-place numbers. The span increases rapidly, to be sure, if the numbers be presented in some schematic order, or if the words unite to form sentences. This contrast between meaningful and meaningless material is significant with respect to the memory process. It is apparent that if memory were a mere wax tablet, it should retain one kind of material as well as another. We must assume that in the case of meaningful things the processes of analysis and synthesis which accompany attention have more to work upon, in the way of associative relations, than in the case of nonsense material. Even with the latter, indeed, the grasping and organizing operations of attentive consciousness show themselves. The learner will unavoidably seek to make familiar words and significant sentences out of syllables that ought to suggest nothing of the sort. The effort to learn the syllables when presented in series leads very frequently, also, to rhythmical forms of repetition of them which seems to be of assistance to the learner. A series of twelve syllables, for instance, will be sung after this fashion:

bam fis / *lup* tol / *gen* ker // *dub* naf / *mit* pon / *say* niz

"Each foot," says Ward, in speaking of experiments in which rhythmizing was observed, "whether disyllablic, or trisyllabic, became a new complex unit, the elements to be connected by successive association being thereby reduced to a half or third, and the whole line seemingly shortened. The varied intonation, again, helped to fix the place of each foot in the verse, thus further facilitating the mind's survey of the whole. Such a transformation can hardly be accounted for so long as retention and association are regarded as merely mechanical and passive processes."

What we have alluded to above as the memory span is sometimes called the *primary memory span.* When a sense organ has been stimulated its activity does not cease immediately upon the withdrawal of the stimulus, but continues for some little time. It is to such continued activity in the retina, for example, that after-images are due. When a learner repeats a series of syllables immediately following their repetition it is probable that he depends, to some extent, upon the reverberation of the stimulus as it persists in his senses. The facts "recalled" are not really dragged up from the past but belong to the rear-ward part of the present. Nevertheless, primary memory alone will not account even for this form of recall, as has been pointed out, else non-sense-syllables would give us as long a span as words or numbers.

The Distribution of Repetitions.—Suppose that one be given a series of syllables to learn, with the understanding that the list may be repeated only twenty-four times. Will the material be memorized most effectively by making twenty-four repetitions at one sitting, or should the repetitions be divided over a number of readings? Jost raised this question and attempted to answer it by actual experiment. His conclusion, verified by other investigators, is that the more the repetitions are distributed the more satisfactory the final result. Jost found that 8 repetitions on three successive days, 4 repetitions on six, and 2 on twelve gave results (measured twenty-four hours after the last repetition), that compare as 11.5, 35, and 54. Later investigators believe that the best results would be secured by twenty-four repetitions spaced as much as three days apart. The same general result has been obtained in experiments with meaningful material, such as poetry or consecutive prose. Indeed, it is said that animals tested in mazes learn better when the trials are well distributed.

Jost advanced the theory that modifications imposed upon the nervous system by the exercise of attentive learning tend for a time to "set" and become confirmed. In our own language the nerves tend to "grow to" the modes in which they have been exercised. By taking advantage of this natural propensity of the nervous system we can make our learning more efficient than it would otherwise be. It seems to be the general opinion that there is "something in" Jost's Law. In practical life, moreover, it is quite likely that in the intervals between our regular readings we would occasionally find moments in which to recall what had so far been learned, and thus to strengthen the memory of it. Even the recall of the associates of the thing, marginally and transiently would probably help to fix it in mind.

Whole and Part Learning.—It has been found that a series of syllables once learned is interconnected not *only* in the order of presentation, as might perhaps be expected, but more or less as a whole, each syllable being tied in some degree to every other. The list of separate items has become integrated into a unit. Ebbinghaus found, for instance, that in relearning a series backward there was a saving of 12.4 per cent of the time originally required for its memorizing. Other ties are shown to exist within a group of syllables once learned.

This fact connects in a suggestive way with the further observation that a long list of nonsense syllables is learned better by repeating them through time after time from beginning to end than by breaking the list into parts to be committed separately. The same is true in even greater degree of meaningful material, such as declamations or poetry. Learning a poem as a whole gives each word and phrase its natural setting in the total composition so that the ties which, as we have just observed, connect part to part within the whole, may fix it in its natural position. Learning a poem by parts, aside from the fact that, as commonly practiced, it given us an unequal distribution of repetitions over the various lines, tends to establish *false associations* which often lead to egregious errors. Suppose that the student is to commit to memory eight lines of poetry:

In her ear he whispers gaily,
  "If my heart by signs can tell,
Maiden, I have watched thee daily,
  And I think thou lov'st me well."

She replies, in accents fainter,
  "There is none I love like thee."
He is but a landscape painter,
  And a village maiden she.

If the student has learned the verses by repeating the first four lines over several times, he has obviously established a tie between *well*, at the end of the fourth line, and *In*, at the beginning of the poem. When, afterwards, he has learned the following stanza in turn, he will set about establishing a second tie between *well* and *She*. Disaster will ensue if, upon the occasion of declamation with its attendant excitement, the false association should happen to gain the ascendency. In the main, then, more correct learning will result from repetition of the subject-matter as a whole. Besides, time will be saved. It has been found, in experiments with both adults and children, that a saving in time amounting to ten per cent is effected by the method of learning as a whole over part learning. In most cases, however, it may be found advisable to give special attention to the more difficult passages which remain unassimilated after the composition as a whole is fairly well memorized.

Associative Inhibitions.—It has been found that if a nonsense syllable has been learned in one series it is sometimes more difficult, on that account, to learn in a second series. The old associations apparently interfere with the formation of new ones. Sometimes rival associations would seem to wipe each other out simultaneously. Such associative inhibition is most likely to ensue when the first learning is incomplete and the associations half-formed. Well established associations, as has been demonstrated, are not likely to interfere with the formation of new ones. We would be in sorry case if that were not the fact.

Learning, then, as all of our experimental results tend to show, is largely dependent for its efficacy upon association and meaning. Bare mechanical repetition gets us nowhere. What we have so far seen is that when attention is concentrated—even upon nonsense syllables—there follows a process by which the members of a presented series become connected by associative ties, such that they tend to call up one another in order. A discussion of association, then would seem to be in place.

But first a special word about nonsense syllables and other material of the "excess baggage" type. In learning a series of these the mind can do no more, apparently, than establish a series of connections *internal to* the data presented. Poetry, on the other hand, can be associated with other established memories, with things we already know, and this the more readily the more meaningful the stanza. Here ties are formed, not only of the internal type, but of the external type as well. This difference no doubt accounts for the greater ease with which meaningful material is memorized.

What psychologists have called *ingenious* memory schemes provide artificial associations which assist in memorizing nonsense material or series of facts that have no inherent logical sequence. Mnemonic systems have been invented and sold ever since the youth of civilization. We find them advertised nowadays in our prominent journals. What is their value? There is no doubt that artificial devices have a certain utility in relation to disconnected facts.

Where pencil and paper cannot be utilized for the retention of such data we all use schemes of one sort or another to aid our memories. Who does *not* use that familiar bit of doggerel for remembering the number of days in the various months? Who has not kept a list of things to be purchased by some such scheme as referring part of them to the butcher, and other parts to the grocer and candle-stick maker? And by remembering that certain of the items are to go into a salad and others into baked beans? *Mnemonic* devices intensify these methods and provide others more elaborate. "The great principle of mnemonic," says Titchener, "is that you remember the novel and the disconnected by bringing it into arbitrary relation to the familiar and connected." Mnemonic systems, however, will not "strengthen the memory" nor are they of any utility in relation to facts sufficiently meaningful to be brought into relation to some established system of knowledge.

Judicious memory, on the other hand, seeks to establish associative connections between new material and our permanent system of experience. We seek to apprehend the thing in *its natural bearings and relationships,* to envisage it as a significant item in a general scheme of things, as when we place a newly discovered plant in some botanical system of classification. In the long run nothing is likely to be permanently retained which is not thus tied by external relations to the enduring structure of every-day experience.

Basic Considerations in Association.—To learn, then, is to associate and to organize, and recall and recognition in their turn must follow the lines of association so established. The fundamental fact, from which we take our departure, is this: that *experience is a system.* Our memory is no more haphazard than our perception. Just as our motor processes are organized, so that our acts in any given situation are coördinated and appropriate, so our sensory activities—including our powers of imaginal representation—are organized and confluent.

An exception to this statement, in the case of memory, might seem to appear in that spontaneous form of revival by which insistent memories sometimes intrude themselves upon our workday trains of thought. Stout cites some good illustrations of spontaneous revival. "An unsolved puzzle such as a chess problem may take so strong a hold on our minds that it persists in haunting us at intervals in spite of our best efforts to exclude it in favor of more important matters. In the acute stages of the war in South Africa, the thoughts of most people spontaneously turned toward the war, whenever they were not otherwise preoccupied, without needing any prompting cue in the way of association. It is spontaneous revival which so often murders sleep. We do our best to divert our minds from some topic which keeps us awake by the importunate persistency of its recurrence. We may succeed for a time, and so drop into a doze. But presently we find ourselves awake again, and again following up the old train of thought with painful intensity."

There is no good evidence that in this form of revival memory does not depend upon associative systems for its efficacy, but rather an interesting note that the general system of an individual's experience is composed, as we might say, of lesser systems constituting together an integrated whole. Thus our chess experiences are so organized as to form an interrelated system. Thinking chess, we move within a certain organized system of associations. The South African war (Stout is an Englishman) constitutes another such experience-system. We shift from one facet of our experience to another very suddenly, sometimes, according to the mode of our interests. In these shifts from one topic to another, from one general field of experience to another, it is true that our consciousness is always limited to some special set of associates; and we must agree that transition from one to the other is sometimes so abrupt as to seem to follow no lines of established relations. In the last analysis, however, it will be found that there *is* some rational pathway from one field to the other. It may be that the Herbartian notion of spontaneous revival finds support in certain abnormal phenomena observed in recent years, but such intrusion of uncalled for ideas is not typical of normal consciousness. Our transitions from fact to fact, from topic to topic, are accompanied by some sense of the rationality of the movement, some reference to the intervening relationships.

Experience is organized. The items that make up the world of our thought and action are *associated* together by connections which, if not "logical" in themselves, at least make logical thought possible. Fact *A* reminds us of fact *B*, since these ideas are associated together within a total system of facts which have a vital bearing upon one another.

The Laws of Association.—There would seem, then, to be a regular order of connection between our ideas; they are connected, as we might say, according to certain laws. This is a tempting suggestion. As physical science formulates the laws of matter, so psychology may be able to formulate, in terms of association, the laws of mind. This attempt has been made in modern times, with very interesting results. Professor Warren has recently given us a *History of the Association Psychology,* in which the fortunes of this adventure in theory are clearly set forth.

Aristotle first called attention to the laws of association where, in his *De Memoria,* he describes the process of recollection. He suggests as laws *similarity, contrast,* and *contiguity.* In Hammond's translation: "When, therefore, we recollect, we awaken certain antecedent processes and continue this until we call up that particular experience, after which the desired one is wont to appear. That is the reason why we hunt through a series in thought, beginning with an object presently before us, or with something else, or *with an object that is similar, or opposite, or contiguous.* In this way recollection is awakened. For mental movements in these instances are identical in some cases, in others simultaneous with the desired experience, and in other cases they involve a portion of it, so that there is a small remainder whose stimulation ensues." In modern days these laws are quite generally reduced to two: similarity and contiguity. In some cases both are reduced to contiguity, or occasionally both to similarity, leaving us only one law. Before attempting to estimate the value of these laws we will do well to try to understand how they are understood and formulated.

The Law of Contiguity.—This law is stated by James in its most general form as follows: ". . . **Objects once experienced together tend to become associated in the imagination, so that when any one of them is thought of, the others are likely to be thought of also, in the same order of sequence or coexistence as before.**"

Nobody pretends nowadays that this law is absolute. Things once experienced together (or thought together) *tend* to become associated in such fashion that when one is recalled it tends to recall the others also. As James indicates, things may be experienced contiguously either in the sense that they occupy consciousness *simultaneously,* or that they are contiguous in the order of time, the movement of attention passing *successively* from the preceding to the succeeding. If, for instance, we experience simultaneously the letters *ZZN*, then, *N* being presented (either in thought or perception) at some later time, it tends to recall *ZZ*. Or, if the letters be presented in succession, one immediately following another, then if *Z* be presented at a later time, it tends to awaken its former associates. Common-sense observation will tend to confirm this law, since we unquestionably do tend to recall the former contiguous associates of a present fact. Thus, the sight of a man's face will frequently remind us of the circumstances under which we formerly met him.

The Law of Similarity.—Things which are like or unlike one another, or which are comparable with respect to the presence or absence in them of some identifiable attribute or quality, tend to suggest one another. White chalk may suggest, on occasion, white snow, or a beautiful face an ugly one. The objects are linked through the medium of the abstract attributes, *white* and *beauty.* The importance of abstract similiarities shows itself in deliberate recall. Suppose we are casting about for something with which to cork a bottle. *Roundness,* of a specific variety, is the abstract quality in terms of which we think of any number of possible objects that might serve our purpose. Or, when a beautiful picture is seen, we may begin to reflect upon beauty in general terms, and recall many instances of things possessing that attribute. It has often been argued that similarity as a basis of recall rests finally upon contiguity. For the objects now thought of as round have each, in some instances, been experienced as round, and this may be translated into the statement that each of the things has been associated contiguously with roundness. But at least it is clear that the objects have never been associated as *wholes,* and even now only in terms of some abstract property which affords a connection between them. If association by similarity is not a distinct genus of association, it is at least a unique variety.

Experiments in Association.—It was but natural that, with the rise of systematic experimental psychology, association should receive prompt attention. Numberless experiments have been made in this field. A standard book in experimental psychology should be consulted for detailed information concerning this very interesting work. So far, as might be anticipated, no conclusive results have been reached. Nevertheless, the data accumulated are highly suggestive and at times illuminating.

Suppose we take a list of twenty words, especially selected for the purpose; let the experimenter now read the list, word by word, the observer being asked to reply in each instance as quickly as possible with the first word that pops into his consciousness. The time required for each reply will be recorded, and the nature of the responses analyzed. The experiment might be conducted, however, on a quite different plan. We might specify that the replies were to follow some logical scheme. We might ask, for instance, for "opposites." The reply to "black" would be "white," and to "up," "down." This would be an experiment in *controlled* association, whereas the first kind of experiment cited would be *free* association.

The method of free associations has attracted a great deal of public attention recently by reason of its proposed application to the detection of crime. It is supposed that a criminal's responses to words which would be associated (according to the law of contiguity) with the crime or the scene of the crime, *would not be normal.* Jung and others have employed free associations tests for diagnostic purposes in cases of mental abnormality. When, by long experiment, the normal or typical responses to a list of words is established, then any serious deviation from the standard is considered significant.

When the results of experiments in free association are scrutinized it is found, as might be anticipated, that the response words are not recalled at haphazard, but in an order which can be interpreted, at least, logically. Very often, indeed, the subject seeking quick response will more or less fall into some logical scheme of response; answering, for instance, to door,—house, and to nose,—head, in terms of part and whole relations. A number of schemes for classifying the various types of association, as these have been brought to light in experimentation, have been advanced in recent times. Consider, for instance, Wells' classification:

CATEGORIES OF ASSOCIATIVE REACTION*

1. Egocentric
    - *a.* Reactions of Modification (*e.g.,* flower-pretty)
    - *b.* Response is Proper Noun
    - *c.* Stimulus Interpreted as Proper Noun
    - *d.* Response Involves Pronoun
    - *e.* No Response; or Repetition of Stimulus
2. Supraordination (individual—Genus)
3. Contrast
4. Miscellaneous
    - *a.* Causality
    - *b.* By Name
    - *c.* Coördination
    - *d.* Subordination
    - *e.* Coexistence
    - *f.* Identity (Synonyms)
5. Speech Habits
    - *a.* Language
    - *b.* Completing or Compounding of Words
    - *c.* Pure Sound
    - *d.* Syntactic Changes

Here is a considerable number of categories of association, and no specific mention of contiguity and similarity. But the table above, of course, is purely empirical; a record of associations actually employed in recall. Perhaps a closer analysis would show that all these very logical modes of recollection are based, ultimately, on continguity alone?

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* See Warren, *A History of the Association Psychology,* for this and other classifications of association.

The Law of Habit.—In the last analysis those who have followed the methods of associationism have been forced to reduce association—in so far as it represents a determinant of our "trains of thought"—to brain terms, to a law of neural habit. "Association," says James, "so far as the word stands for an *effect*, is between *things thought of;* it is things, not ideas, which are associated in the mind. And so far as association stands for a cause, it is between *processes* in the *brain;* it is these which, by being associated in certain ways, determine what successive objects shall be thought." Contiguity and similarity, and the list of connections cited by Wells, and hosts of other relations, may, as James remarks, be *thought of,* as we describe the fashion of our trains of thought. But such mental connections *explain* nothing. They do not tell us *why* the one thought followed the other. The explanation is to be found in laws of neural, not mental, connections. Contiguity reduces to the law of habit. "Thus, for instance," says Royce, "the speaking of any word in our language involves a cerebral function, which has in the past been connected with great numbers of other functions, since we have spoken this word in the most various contexts, and have connected the speaking of the word with very different other functions. In consequence, the general law of habit insures, indeed, that the word, if familiar, shall arouse certain functions which are inseparably associated with it." I pass in thought from white chalk to white snow, not because of any force operative in the concept *white,* but because the nerve centers which represent these two words are connected, in the brain, by established paths of nervous conduction, such that a stimulus exciting the one will likely overflow into the other.

According to this scheme thought, as such, has no laws of its own. The mind has no explanation of its own. One thought follows another, it is true, inevitably and in perfect sequence, but the real seat of this logicity is in the brain. Thus modern associationism.

Origination of Associative Connections.—There can be no question that we do tend to re-think things in the order of their original presentation, and it is true that this statement can be translated into brain-terms and in that form possess considerable explanatory value. On the other hand, *habit never established a habit.* The construction of an associative bond between two items of experience is the work of attentive consciousness. Attentive activity is forever at this work; it is the builder of habit. Now attention, as we have seen, is not mechanical and reflex; it *is* precisely what the mechanical *is not.*

Attention is forever carrying on its analytical and synthetical processes. It is by such activities and through them that habits, associations, mental and nervous connections alike, from the most subtle logical sequence to the most complicated cortical patterns, become established. Attention, we have said, is sensori-motor, an affair of consciousness and of brain alike. It is an "organismic" reaction in which all the elements of personality participate. From it proceeds the order and system of experience thus far established, and through it the systems of tomorrow must be built up. It is the center from which psychical development buds and grows towards the future.

Attention Controls Learning.—In learning, then, what controls the process is attention, if attentive consciousness be considered in its whole range of implication. We do not hold up objects to the wax tablets of the mind, as even some modern theorists would seem to insinuate. We grapple actively with the material to be learned and our power to remember is directly proportional to the depth of penetration which attention achieves. We must agree, of course, that some kinds of material offer more resistance to the attentive activities than others, so that effectiveness in memorizing is conditioned by the nature of the subject matter as well as by the intensity and duration of attention. But these statements come to one in the end.

The technique of the memory process, accordingly, should provide no more than an opportunity for the effective exercise of attentive consciousness. This is largely a matter of presenting the material in such form that attention may develop its *meanings;* thus relating it to the general body of our experience, while at the same time evolving the *internal* connections of the material. Suppose it be our task to memorize Spencer's definition of evolution:

"Evolution is an integration of matter and concomitant dissipation of motion: during which the matter passes from an indefinite, incoherent homogeneity to a definite, coherent heterogeneity; and during which the retained motion undergoes a parallel transformation."

Bare, senseless repetition would never do for the conquest of such a passage. But, we shall be told, the bare verbal repetition might result, eventually, in the establishment of a *verbal habit* that, once acquired, could be set going at pleasure, like a phonograph record, and reproduce the words of Spencer's formula. This is no doubt true. We can form verbal habits, just as we form other kinds of motor habits. But surely nobody would ever think it worth while to "learn" the definition merely for the sake of being able to repeat it, parrot-like, at some future time? If we are really to grasp it, and make it our own, the learning process must include a great deal more than mere verbal repetition.

First of all, we must understand the words, and if we do not already know their meanings we must search the dictionaries. Next, the separate propositions must be understood, such as—"Evolution is an integration of matter." Why go any further until this is cleared up? Finally, we must see how the several ideas that compose the passage do logically follow and support one another. When these preliminary steps are taken we shall be in a position to learn the material by thoughtful repetition. Nobody doubts that in the case of material of this kind meanings must be developed, both those internal to the definition and those which show its wider bearings. We remember, then, to the extent that the attention process is able to develop the meaning, the sense, the denotation and concrete reference of the symbols presented.

But here, perhaps, we should take note of a qualification suggested by McDougall. "The importance of the meaning is well brought out by consideration of the following example. I set myself to learn a row of twenty nonsense syllables, and I find, perhaps, that one hundred or more repetitions are needed to enable me to reproduce the row. Then I take a passage of prose or verse containing twenty syllables, and I find that I can reproduce this row after a single reading. How immense is the difference between the two cases! This difference is due partly to the fact that in the second case the syllables form words each of which has a meaning for me; but chiefly it is due to the fact that their several meanings are synthesized to one whole in my consciousness, namely, the meaning of the whole passage. The meaning seems to bridge the series of sense-impressions and to bind them together. But, just as in the case of the reproduction of the nonsense syllables the factor of meaning is not altogether inoperative, though reproduction depends chiefly upon the links of mechanical association, so in this case the mechanical factor is not altogether lacking, though meaning plays the predominant part; for I may find after an interval that, though the meaning of the passage may return to my consciousness, I am unable accurately to reproduce the words of the original." The question thus raised as to the importance of the two factors, *meaning* and *habit*, is indeed, one demanding serious consideration. Our answer to it will appear in the course of our discussion of retention and recall.

Retention and Habit.—So much, then, for our learning processes. But what, in the light of the discussion preceding, can we now say about retention? Let us recollect that retention intervenes between the two conscious moments in which learning and recall take place, and that the interval is often very long. Clearly then, the conditions which effect retention, *per se*, lie outside consciousness, so that the explanation of retention is to be found in habit, if anywhere. During the learning process the nervous system is exercised in certain modes, and "grows to" those modes. We may suppose that a set of neurones, in the course of such exercise, become tied together to form a functional system which, once established, may at some future time be re-excited. But retention means, from the side of consciousness, no more than *liability* to recall. The conditions which govern it, we said, are sub-conscious, or rather, extra-conscious. So considered retention may be said to depend upon some property of the organism not yet understood.

It is a favorite theory among many psychologists that some individuals have a greater native power of retentiveness than others, due to a superior capacity of the nervous tissue. We would consider this doubtful, in so far as this hypothetical capacity is thought to affect *memory alone*. The exceptional nerve property should show its hand in all of the intellectual processes, if in one. There can be no question, however, as to the reality which this special capacity of the nerve tissue is presumed to explain, the superior power, namely, which some persons exhibit in the form of desultory memory. Unquestionably we find here wide differences between individuals, whatever the ultimate explanation may be. It is simply a fact, which for the present must be accepted as final. And, it would seem, there is simply nothing to be done about it.

Memory cannot be improved, then, so far as it depends on "natural retentiveness," either by exercise, or by eating phosphorus or cod liver oil. All that we can do is to improve our methods of learning. Since we have already discussed the *modus operandi* of the learning process in another connection, we might reënforce it here by James' lively statement. "The 'secret of a good memory' is thus the secret of forming diverse and multiple associations with every fact we care to retain. But this forming of associations with a fact, what is it but *thinking about* the fact as much as possible? Briefly, then, of men with the same outward experiences and the same amount of native tenacity, **the one who THINKS over his experiences most,** and weaves them into systematic relations with each other, **will be the one with the best memory.** We see examples of this on every hand. Most men have a good memory for facts connected with their own pursuits. The college athlete who remains a dunce at his books will astonish you by his knowledge of men's 'records' in various feats and games, and will be a walking dictionary of sporting statistics. . . . The great memory for facts which a Darwin and a Spencer reveal in their books is not incompatible with only a middling degree of physiological retentiveness. Let a man early in life set himself the task of verifying such a theory as that of evolution, and facts will soon cluster and cling to him like grapes to their stem. Their relations to the theory will hold them fast; and the more of these the mind is able to discern, the greater the erudition will become. Meanwhile the theorist may have little, if any, desultory memory."

The Rate of Forgetting.—Experiments in memorizing have given us a "curve of forgetting" of which a typical example is here shown in diagram.

We find here that the rate of forgetting is very rapid in the first few minutes and hours; then it falls more slowly, until we find eventually a certain small residuum that is retained indefinitely. Thus Ebbinghaus forgot 41.8 per cent of memorized material in twenty minutes, 55.8 per cent in the first hour, 66.3 per cent in the first day, and 78.9 per cent in thirty days. This result has been confirmed, in its general form, by a number of other investigators.

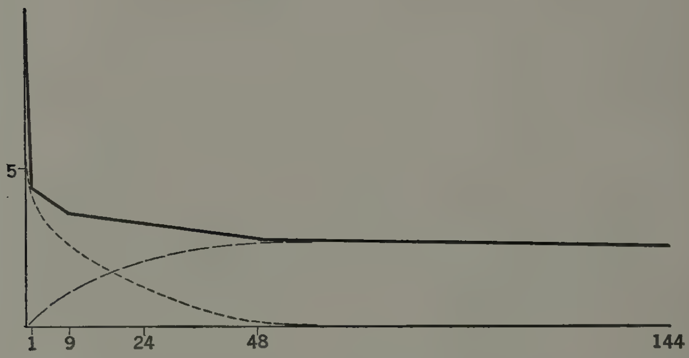

FIG. 37.—Analysis of the curve of forgetting to show possible coöperation of perseveration and association. The full line shows the course of forgetting after Ebbinghaus, the dotted line the conjectured decrease in the primary memory (perseveration) and the dashes the initial increase in the strength of association due to perseveration.[1]

Material thus forgotten, however, is often found to be "sub-consciously" retained to a certain degree. For it has been shown that material once learned and forgotten past possibility of psychical recall, can nevertheless be relearned with fewer repetitions than were required for the original learning. The organism still retains traces of the original nervous impression, even though means are lacking to project the memories above the "threshold of consciousness." The question has often been asked, in this connection, whether anything is ever completely forgotten. Strange cases have been cited to show that memories apparently buried forever in oblivion can, under proper conditions, be revived in normal intensity. If we follow analogy, however, it seems likely that most of the impressions which we receive are not permanently retained, except in so far as, in their original reception, they affected the general balance of our organic adjustment.

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[1] Pillsbury's Fundamentals of Psychology. Copyright 1922 by The Macmillan Company. Reprinted by permission.

And again, from a practical point of view, it is *necessary* for us to forget a great deal. If we were to remember all the details of a past event, for instance, how could we ever retraverse the experience in order to find in it what we want? We retain, for purposes of psychical memory, at least, only the main outlines of past experiences. Ribot, in a passage in his *Maladies de la Mémoire,* emphasizes this point. "As fast as the present enters into the past, our states of consciousness disappear and are obliterated. Passed in review at a few days' distance, nothing or little of them remains; most of them have made shipwreck in that great nonentity from which they will never more emerge, and they have carried with them the quantity of duration which was inherent in their being. This deficit of surviving conscious states is thus a deficit in the amount of represented time. The process of abridgment, of foreshortening, of which we have spoken, presupposes this deficit. If, in order to reach a distant reminiscence, we had to go through the entire series of terms which separate it from our present selves, memory would become impossible on account of the length of operation. We thus reach the paradoxical result that one condition of remembering is that we should forget. Without totally forgetting a prodigious number of states of consciousness, and momentarily forgetting a large number, we could not remember at all.

Oblivion, except in certain cases, is thus no malady of memory, but a condition of its health and life.''

Organic Recall.—Recall may be merely organic, as when a habit is set going and proceeds to reel itself off without conscious attention. This form of recall, while not psychical, has some characteristics that must be understood before we proceed to the discussion of memory proper.

The first thing to be noted is that organic recall is appropriate to the bodily action going forward at the time. Nailing a board on a fence, for instance, may involve a vast amount of this inattentive kind of recall. One motion of wrist, arm, or body follows consecutively upon another; one look, one perception, one image, follows another in sequence, each in its time and place.

Even organic recall, then, implies selection, but a selection that is specified, not by attentive choice, but by the organism itself in its habitual modes. Nobody has better expressed this truth than Bergson. ''Let us, for the moment, suppose our psychical life reduced to sensori-motor functions alone. . . . In this state every perception spontaneously prolongs itself into appropriate reactions; for analogous former perceptions have set up more or less complex motor apparatus, which await only an occurrence of the same appeal in order to enter into play. Now there is, in this mechanism, an *association of similarity,* since the present perception acts in virtue of its likeness to past perceptions; and there is also an association *of contiguity,* since the movements which followed those former perceptions reproduce themselves, and may even bring in their train a vast number of actions coördinate with the first. Here then we seize association of similarity and association of contiguity at their very source, and at a point where they are almost confounded in one—not indeed thought, but acted and lived.'' Organic recall is mechanical, a matter of habit, and physiological selection is based directly on habit.

The second point to be made is that this kind of recall merely *occurs,* or takes place, as the rain falls, without any direct attentive effort on our part. If we could go on forever, acting directly and fluently, making responses without hitch or jar, psychical memory would never occur. It is when direct action is suspended, in the face of a problematical situation, that true memory begins to operate. And in this we find the real province and function of remembering as a form of conscious activity.

Psychical Recall.—A true memory, in the psychical sense, is never a mere reproduction or repetition. On the contrary, it involves always a working over of past data, a redistribution of light and shade and a resketching of outlines. This is because when we recall a thing psychically it is with an eye to its bearings upon a present problem. Thus one may, in the course of analysis of the political situation, call to mind many facts connected with the campaign of 1920; but these will be remembered, not as so many brute facts-in-themselves, but in terms of their bearings upon questions now being raised. They will not be apprehended in their original form, as originally experienced, but selectively, and with direct reference to the subject-matter that sets the attentive problem. Here the recall will not be automatic, but, as we often put it, *voluntary.* But even more important is the consideration that in becoming once more attended to, the memories will be thereby worked over, seen in new relationships and bearings, and given new meaning. It is by such psychical activity that the past is being constantly reconstructed and revaluated.

Direct Psychical Recall.—Psychical memory is direct, we have said, when no effort is required to drag a fact up from the past; when it comes when called for. We must not confuse this with spontaneous revival. There is always a sense, perhaps, in which the fact is searched for, even though it does not have to be "dug up" when located. Psychical remembering is always a kind of looking about and taking stock of things. Suppose one finds a spot of paint on a new suit of clothes. How did it get there? Attention quickly passes over the events of the day, reviewing them in some sort of logical sequence, until the appropriate memory is forth-coming. When the wanted memory is located the problem is solved. Such a memory is *direct* when the fact does not have to be cajoled into showing itself. It appears naturally in its place and order.

This direct and natural form of remembering is fundamental and characteristic. It is psychical, because the object is *attended to,* either on its own account or, more likely, because of its bearings on a present problem. The mode of operation of attention in such situations is interesting. Suppose, to take a fairly simple instance, that one is trying to "make out" the nature of some object, such as a bolt that has been picked up by chance. Attention fixes and analyzes the object. Each of the details or aspects of the object thus analyzed suggests a line of associations which *resemble* it. Thus the pitch of the thread will suggest, to a mechanic, a whole line of bolts used for various purposes; the character of the metal will call up another train of associates; the color, if the bolt be painted, another. And thus a great number of things will be thought of, all as bearing on the solution of the question in mind. Each item, as recalled, will be scrutinized, then passed over as unimportant, or accepted as relevant. This, or something like it, occurs whenever things are psychically recalled.

The object which sets the central problem may itself, of course, be a past event. But the process of recall as related to the controlling topic is of the same order as when the problem is set by a present object. The selection of memories is governed by the task in hand, and recall is no longer the automatic unwinding of the scroll of the past, but an active scrutiny of our memories.

Selection in Psychical Recall.—Attentive reference to past events is thus a selective mode of bringing past experiences to bear upon the present. Two points are to be noted. In the first place, the attentive process of recall *leans upon habit*. In trying to "place" an object we seek out its habitual associates; those which have, in times past, been related to it in terms of contiguity, similarity, or whatever else expresses customary relationships. This, it will be seen, is a way of saying that psychical recall *utilizes* organic memory. To a large extent the ability of an individual in handling a problem will be dependent on the richness and variety of his accumulated fund of facts.

But, in the second place, we do not employ all of our past experience in any situation, nor even any considerable portion of it, but only such part as is relevant. Psychical memory *plays over* the organized experience of the past, making its *selections* in anything but an habitual manner. In such a process memories will be juxtaposed and united which have *never* been experienced before in any kind of contiguity. Psychical memory rests upon habit, but it itself is spontaneous and original. Thus one may never have even remotely remarked any connection between the customary state of Mr. A's raiment and his wife's temper. But incidental rumination upon the possible causes of a missing coat-button may bring the two together with a logical movement as irresistible as that by which we add two and two. In short, the situation of psychical memory is one in which new connections get made. It is constructive and reorganizing.

Deliberate Recall.—Although deliberate psychical recall is essentially the same, in its inner movement, as the direct form, it nevertheless has features of its own which make it conspicuous. From a practical point of view we come here upon a defect of memory, in so far as reminiscence fails to operate directly and must be aided. The process by which we go about recalling a forgotten fact is consciously initiated, and sometimes sophisticated in the extreme.

Suppose, for instance, that we have occasion to recall a name that stubbornly refuses to reveal itself. In our diagram let *A* represent the forgotten fact, and *a, b, c, d, e, f,* represent items which in times past have been associated with it. Let *X* be the line of thought which gives occasion for the desired recall.

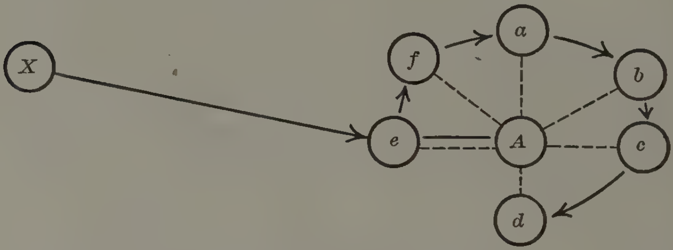


FIG. 38.

Since we cannot recall *A* directly, we resort to the device of calling up *A*'s associates, *a, b, c,* etc., in the hope that one of them may finally resuscitate *A*. As James has it: "In short, we make a search in our memory for a forgotten idea, just as we rummage our house for a lost object. In both cases we visit what seems to us the probable *neighborhood* of that which we miss. We turn over the things under which, or alongside of which, it may possibly be; and if it lies near them, it soon comes into view.

We may translate our diagram without difficulty into a representation of the nerve connections which underlie our memory. Our aim, then, in physiological terms, seems to be to hit some associate of *A* which has a path of low resistance leading to the *A* center. Sometimes we have to wait, apparently, until the inter-excitation of the several nerve centers involved has raised their potential to a point where a nerve current can be forced over some pathway into *A*. Sometimes, again, the attempt must be given up for the time, but, on the next day, perhaps, when we are thinking of nothing directly connected with the subject, *A* may pop into consciousness out of a clear sky. The only explanation for this would seem to be that some wandering nerve current has accidentally hit into the complex of connections, still in a state of excitation, and suddenly raised the potential of the system, by its small contribution, to a point where a current is shot suddenly into the *A* center, with consequent revival.

This technique clearly takes advantage of the *habitual* associates of the thing to effect its revival. It is a *mediated* form of recall, in so far as it occurs through the thing's associates as middle terms. The procedure seems to be a kind of deliberate stimulation of the processes of *organic* recall. We try to set the habitual processes going in the hope that the desired fact may be automatically presented. But, of course, the attentive acts by which we stimulate the various centers are not themselves automatic. Anything, apparently, but that!

Recall and the Psychic Fringe.—The forgotten name that we desire to recall is not, after all, strictly forgotten. If it were, how could we *want* to recall it? We do know that there is such a name, and we have in hand, usually, the data which will enable us to recognize it when it appears. The gap in our memory is not a mere gap, but a vacancy surrounded by what James calls a "fringe," whose nature is such that only one fact will fit that particular place. This fringe of associates may be either fairly definite, or vague and elusive, but in any case it furnishes the clues by which we hope to find the desired memory.

The peculiar type of experience nowadays called *paramnesia* presents a state much like that described above, but in exaggerated form. Very often a person, finding himself in a situation that is, to all appearances, new, will have the strange and irresistible conviction that he has at some time been in exactly this place before, acting or speaking as now. There is the uncanny conviction that this present experience is a point for point repetition of an event long since forgotten. It suggests pre-existence and all sorts of occult explanations. There is more likelihood, however, that the present state recalls a *similar* precious experience. All that is left of the old experience is a vague halo or fringe which, now feebly excited, points towards the past; and, fusing with the present perception, it endows it with the vague but intangible suggestion of past time which is its sole content.

All this indicates that in psychical recall we refer things to their places in the context of experience. Things are known, identified, characterized, in terms of their associative connections. This is what the term *recognition* connotes. Some psychologists have spoken as if recognition is wholly a reference of facts to their *date in past time.* That notion is too narrow. What we do, rather, is to refer them to their places in the system of our experience, with its manifold relationships of space and time, cause and effect —and all the rest. So insistent is this identification of things by their associates, as we have remarked, that the associates may be known while the fact yet remains submerged. The fringe glows while the object still remains obscured.

Fundamental Considerations in Memory.—In our discussions of memory, in this chapter, we have been compelled to swing back and forth between two vital factors: on the one hand an organized system of experience, whose law is habit, and on the other the attentive process which is the architect of this experiential system: perpetually active, too, in its maintenance and development. The complete explanation of memory cannot be made without reference to *both* of these factors.

Many psychological discussions of the memory process have been tilted, in our opinion, by the attempt to explain learning and recall exclusively in terms of habit. The function of active attention has been passed by as interesting but inconsequential. We have argued elsewhere that the conscious processes gain their whole significance by *contrast* with the reflex and the mechanical, the routine and established. We must take care, however, in the case of memory, to acknowledge the large element of truth which the traditional associationistic explanation does contain. This is, that the law of habit is primary in the explanation of retention, and that psychical recall rests upon organic memory.

"I value the praise of Memory," sings Emerson. "And how does Memory praise? By holding fast the best. A thought takes its true rank in the memory by surviving other thoughts that were once preferred. Plato remembered Anaxagoras by one of his sayings. If we recall our own favorites we shall usually find that it is for one crowning act or thought that we hold them dear.

"Have you not found memory an apotheosis or deification? The poor, short lone fact dies at the birth. Memory catches it up into her heaven, and bathes it in immortal waters. Then a thousand times over it lives and acts again, each time transfigured, ennobled. . . . You may perish out of your senses, but not out of your memory or imagination."

CHAPTER IX

IMAGINATION

> "The inconveniences of an ill-regulated imagination have appeared to some philosophers so alarming, that they concluded it to be one of the most essential objects of education to repress as much as possible this dangerous faculty. But . . . it is in vain to counteract the purposes of Nature. . . ."—DUGALD STEWART

Memory and Imagination.—We are accustomed, in our discussions of retentiveness, to speak of memory in wholly practical terms, for memory has an immediately utilitarian function which we can at once recognize and appreciate. Imagination, however, we represent as novel and romantic, since it is concerned with those more spontaneous, fanciful, play activities of thought which carry us beyond the stolid realities of common-place existence.

> "When nature rests,
> Oft in her absence mimic *fancy* wakes
> To imitate her, but, misjoining shapes,
> Wild work produces oft."

This is a popular and restricted sense of the subject-matter of this chapter. It represents a so-called *creative* as distinct from a *reproductive* imagination. *Reproductive* imagination is the *recall*, the *revival* of our last chapter. It is not "misjoining shapes"; it is "joining" them in objective fidelity. It is a bringing up again a mental picture of, *e.g.*, the house in which we live when we are at home. We see it again in our "mind's eye." Its form and its various colors even, within and without, are distinct as if we were truly standing before it. The imagination called *creative* is not so in any absolute sense. It, too, is a revival of elements that are forthwith conjoined in a new way, as when we dig out some old stones and put them together to form a new house; or as when we tear in pieces old stories of hunting foxes and rabbits in Wisconsin and make of them a new story of hunting lions in Africa where we have never been.

Psychologists recognize the common meaning of the term Imagination, but, for technical reasons, employ it more frequently as a basic concept of much wider range. In this broader usage it designates our general capacity for reproducing the past presentations of experience and denotes all contents of presentational consciousness not attributable to direct sensory stimulation. Now the past, in the form of re-presentations, we have said, enters insistently into the present. We have had to reckon with it so far in discussing memory, attention, perception—and it will appear even more insistently in the higher processes of thought which we have still to investigate. Mental experience without imagination—in this wider sense—is inconceivable. The past *must* be present if we are to think at all. ''In its entirety, probably, it follows us at every instant; all that we have felt, thought and willed from our earliest infancy is there, leaning over the present which is about to join it. . . .'' If Bergson's statement be exaggerated it is none the less true that imagination, in the general sense of the term, is a constituent of every waking experience, so intertwined with the presentations of sense that it can only be isolated by the most heroic introspective effort. We cannot advisedly undertake to discuss imagination in this all-inclusive sense. It will be better to follow custom, taking note of the imaginative contents of experience as occasion permits, in connection with each of the several topics with which our study is concerned. As we have spoken of it in connection with attention, perception, and memory, so we shall note its presence and contributions in conception, reasoning, willing, and the other conscious processes in turn.

In this chapter we shall confine ourselves primarily to imagination in its more ordinary and restricted sense, as differentiated from practical memory and from automatic reproduction. The term *creative* or *constructive,* as applied to imagination, does not connote the building of practical sequences of thought, and that alone. It is often playful and irresponsible. It will not do to overlook the vagaries of imagination, especially since these have, according to the psycho-pathologists, a great deal more significance than we commonly attribute to them. Let us urge once more, as we have done on the preceding page, that we conceive of no *absolute* sense in which imagination is creative or constructive.

Imagination and Reproduction.—However great the variety and novelty of our imaginative representations, the *images* of which they are composed, according to our authorities, are *copies of originals once experienced sensationally.* "There is nothing in the mind which was not first given through the senses," runs the traditional formula. A man born blind will never be able to imagine colors, nor one born deaf, sounds. Nor, on the other hand, would it be possible for a normal person to imagine a color unlike anything hitherto experienced. It is beyond the power of our imagination to conjure up new tastes, smells, sounds, or other qualities of experience. We might as well try to lift ourselves by our own boot straps.

This statement is often taken, by students, to be a denial of the originality which imagination so obviously does possess. But, it must be answered, imagination has all the spontaneity which it *seems* to have—no less. Let us con-sole ourselves with the observation that sensation itself (except, perhaps, in baby-hood) is never wholly original. For *who ever saw or heard anything that was not like something he had seen or heard before?* Such newness is foreign to our experience; novelty is always relative. Insistently the mind assimilates the new to the familiar in terms of similarities and the new *must* somehow resemble the old or remain inscrutable. While, therefore, the basic qualities of things are first given through the senses, there is a respect in which imagination may present more novelty than perception, for fancy can weld its images into all sorts of ‘‘really impossible’’ combinations and synthesize elements which nature never intended to keep company.

Original presentation, nevertheless, is the ground from which imagination derives all its materials. Imagination works with the same stuff that perception employs and draws it from the same sources. Perhaps the common statement, which we have employed, that images are *copies* of perceptions, is rather wooden. Images are almost never literal copies, but rather original views retouched and worked over by the artistry of consciousness.

Images and Perceptions.—Images may, on occasion, have all the vivacity of sensational objects; may counterfeit reality. In the ordinary course of experience, however, this is the exception. There are several ways in which we may characterize the typical differences that hold between perceptions and re-presentations. First of all, our sense impressions are commonly more *intense* than their corresponding images; have in Hume’s words, more *force and liveliness.* Thus if one perceive an orange, and, after a lapse of time, recall it imaginatively, the reproduction will lack the intensity of the original. Faces imagined are not as vivid in form or color as faces seen, nor are sounds imagined possessed of the urgent and obtrusive character of auditory perceptions. This difference in intensity between original and re-presentation is typical, but far from absolute. A very weak sensational impression has, in a sense, no more intensity than images have. It has been found, under experimental conditions, that weak sensations may be mistaken for imaginal presentations, on that very account.

But, again, images as contrasted with percepts are usually blurred and ill-defined. An object perceived usually, but not always, shows its details, outlines, qualitative aspects, with distinctness. But very few people can reproduce such a perception with anything like its original fund of clearness and detail. There are individuals, however, as we are presently to see, who are able to reproduce things seen or heard or otherwise experienced with astonishing distinctness. Such people are exceptional. In general, re-presentations are fragmentary and vague as compared with their originals. Perceptions, once more, are *steadier* than images, under ordinary conditions. For the perception is accompanied by a continued stimulation of the organs of sense which give solid body to the impression so long as it lasts. Images, on the contrary, are characteristically fluctuating and instable. They rise and fall in intensity and, lacking spatial position and context, drift and scatter adventitiously. Finally, percepts alter in accordance with our *bodily movements,* so that any obstacle intervening between stimulating object and sense organ (such as the eye-lids) snuffs out the perception. But images do not appear to depend upon the sense-organs; they persist in spite of bodily movements which alter sensory contacts. One of our ordinary proofs of the perceptual reality of an object, of course, is to subject it to the sense-organ test; to determine whether it comes or goes with the interruption of a stimulus. Or, if the presentation be (for example) visual, it can be checked off against touch, audition, or some other of the senses.

Such are the differences between sense impressions and images which have been most frequently cited by psychologists. If we seek, however, a practical criterion for distinguishing the two forms of presentation, this will be found to best advantage in the *associative context* of the experience. Experiments have shown that it is possible, by a strong effort, to *project* visual images into the external world, alongside really perceived objects. But the imaged object does not "fit into" the normal situation. Our perceptual worlds are organized and systematic. They exclude the fanciful and vagrant by virtue of the coherence of their objects. A frail butterfly *might* perch upon a snow-bank in mid-winter, but the unlikelihood of such an event would cause us, on occasion to mistrust our senses. However closely a projected image might approximate the appearance of a perception, it would have to be a genuine possibility of the total situation presented in order to stand unquestioned.

Intermediate Forms.—Between ordinary sense perception and our typical ideational experiences, contrasted as we have noted, stand certain intermediate forms of presentation. We discover thus a certain continuity between perception and imagination which serves to make the latter at least more natural and understandable.

The first of the intermediate forms are the so-called *after-images*. These (See Chapter IV) are most conspicuous in the field of vision where, at times, they become a positive annoyance. Visual after-images, we have said, result from the persistence of the excitation produced in the retina by the original stimulation, after it is withdrawn. These may endure for a considerable length of time provided the stimulation has been strong and the conditions favorable for observation. After-images, both positive and negative, partake somewhat of the character of true images. They are fainter than their originals, less clearly defined, independent of the opening or closing of the eyes. On the other hand, they share the *persistence* of sense perceptions, because they are conditioned by actual sensory excitation.

A second intermediate form of presentation, not so commonly noted, is to be found in *recurrent sensations.* It will sometimes happen that, the senses having been vigorously stimulated, the original experience will recur long after the sensory processes should have settled into equilibrium. Men who have been busily engaged in some kind of close work such as portrait-painting or microscopic study will often find the objects of their study vividly presented in the dark. Such images have much better definition than the casual reminiscences of our sleepy states. The evidence would seem to indicate that recurrent sensations depend, not upon continued sensory excitation, but rather upon cortical conditions.

Finally, we have the *primary memory-image,* or memory after-image, as Fechner called it. This, too, depends upon the persistence of the original excitation not, however, primarily in the sense-organs, but rather in the brain centers. Thus, if we look intently at an object for a moment, and then turn the eyes away, an *image* of the object may appear and last for a brief time—provided it be kept in the focus of attention. These images may serve all the purposes of actual perception for the scrutiny of an object, as experiments have shown. They differ from after-images in that they have not the same degree of sensory support, as is shown by the fact that, like true images, they can be sustained only while attention is kept upon them, whilst after-images may persist in spite of our efforts to exclude them from consciousness. It will be seen, then, that primary memory-images stand mid-way between perceptions and true images.

The Physiology of Revival.—We have already given, in our chapter on Memory, the conventional physiological explanation of retention and revival. It may not be amiss, however, to add here a few notes naturally suggested by the subject-matter with which we are now dealing.

In the thought of certain of the older associationistic psychologists the physiological process involved in revival was represented all too literally and mechanically. It was assumed that the nervous modification which renders possible the revival of any given idea is attributable to some one nerve cell, which stands, so to speak, as its sponsor; and it is a part of the same conception that every idea has its physiological seat in some particular cell. Let any one cell or group of cells be excited and we should have a reproduction of the original perception. The difficulty with this scheme, and with any that resembles it in outline, is that it takes no account of the *very extensive* neural excitation which apparently does and must accompany any re-presented experience.

We must note, first of all, that our typical images are reproductions of original perceptions (not mere sensations). Perception, we have seen, usually involves contributions from more than one of the sense departments as well as from various image departments. Listening to a piano concert, for example, involves not only auditory, but visual, and perhaps kinæsthetic and organic impressions in some people—not to speak of the images which supplement the sensory impressions. Now we know, as the result of numerous studies, that the visual, auditory, and other sensory projection areas of the cortex are widely distributed over its surface, so that the neural excitation attendant upon a perceptual experience of that kind cannot very well be referred to some one "center" of the brain. In *every* perception similar conditions would seem to prevail. We could only get an *image* of the original object by an excitation that would reinstate at least the essential aspects of the primary experience. Images are seldom—if ever—merely visual or auditory, but involve many sense departments.

There is a further consideration. For images of objects come to us as wholes—in the sense that they appear as totals rather than by piece-meal. The same is true for perceptions. We do not first get a visual sensation and, thereafter, an influx of images which add up to give us the representation of an object. This observation has a distinct bearing upon the *spread* of nervous excitations in the brain. The incoming current cannot be said to pass up to the occipital lobe, and to spread from there in serial order to other centers, adding imaginal increments as it goes. The visual excitation, on the contrary, seems to touch off the whole system either simultaneously or in incalculably rapid order. If perceptions take any time in maturing —in the sense here meant—it must be remarkably short and, in common life, negligible. So also with images, which spring into consciousness full-fledged and with their contexts already unfurled.

These considerations should serve to remind us that the nervous system, at least in mental activity, acts in cycles and phases, rather than in parts and combinations. Nevertheless, it must be agreed, *brain excitation* of some kind is the essentially physiological fact in imagination. Is anything besides the brain involved?

Imagination and the Senses.—Evidence has come to light in recent times which would seem to indicate that, on occasion, imagination may be accompanied by excitation in the sense organs as well as in the brain. There is, as James remarks, something paradoxical in the notion that nerve currents may run backwards from the cortex into the sense-organs; but this does appear to happen.

Certain experimenters who are good visualizers report that, when they image a color (red, for example), in strong attention, they may afterwards obtain its *negative after-image;* which images, we have seen, are of necessity explained by retinal excitation. Mellone and Drummond cite a case of slightly different type. "Recently, lying half-awake but with my eyes shut, I saw an intensely vivid image of a face of an old woman, a very pleasant face, except that the eyes were so bright as to be repulsive. It lasted about two seconds, leaving a distinct negative after-sensation of the eyes—two dark spots, my own eyes being still closed." It is possible, of course, to explain such phenomena as incipient hallucinations which cluster about some sensory content as their *point de repere.*

The production of sensory excitation in subjects who are in the hypnotic state is well authenticated. "If," says Binet, "we make a red cross appear on a white sheet, the patient, after having contemplated this imaginary cross for several moments, sees upon another piece of paper a green cross." The after-image so produced, experiments show, have all the characteristics of true retinal impressions. In view of these facts, then, we scarcely afford to be more conservative than James. He has expressed his belief that the subjective difference between imagined and perceived objects is less absolute than had been claimed, and that the cortical processes in imagination and perception are not wholly distinct.

If we cannot be sure that nerve-currents run backwards from brain to sense organs in imaginal experience, we can at least be sure that, even under ordinary conditions, a great many currents do run *forwards* into the motor nerves. These show themselves in emotional reactions, with the bodily changes appropriate to them, and in incipient motor movements which occasion kinæsthetic sensations. Most people, in imagining an object, cannot refrain from adopting, in some degree, the motor attitude appropriate to it. All in all, then, we see that imagination is not to be explained by *local* cortical excitations, and, probably, not by cortical excitation alone; imagination, like perception, would seem to have a *sensori-motor* basis. It seems to depend upon some kind of redistribution of potential within the organically integrated nervous *system*.

Galton on Imagination.—One of the most interesting lines of investigation initiated in modern times concerns the differences which individuals exhibit in their characteristic imagery. Although Fechner called attention to these differences in 1860 it was Galton (about 1880) who really set investigation afoot by his extensive questionnaire method of gathering facts on the subject. His object was to discover to what extent people really represent things to themselves in imaginal terms, and how and to what extent individuals differ in the type of imagery used. The results surprised Galton himself.

"It is not necessary," says Galton, "to trouble the reader with my early tentative steps. After the inquiry had been fairly started it took the form of submitting a certain number of printed questions to a large number of persons. . . ." The first group of the rather long series of queries related to the illumination, definition, and coloring of the mental image, and were framed thus:

" 'Before addressing yourself to any of the questions on the opposite page, think of some definite object—suppose it is your breakfast table as you sat down to it this morning—and consider carefully the picture that rises before your mind's eye.

" '**Illumination.**—Is the object dim or fairly clear? Is its brightness comparable to that of the actual scene?

" '**Definition.**—Are all the objects pretty well defined at the same time, or is the place of sharpest definition at any one moment more contracted than it is in a real scene in daily experience?

" '**Coloring.**—Are the colors of the china, of the toast, bread-crust, mustard, parsley, or whatever may have been on the table, quite distinct and natural?'

"The earliest results of my inquiry amazed me. I had begun by questioning friends in the scientific world, as they were the most likely class of men to give accurate answers concerning this faculty of visualizing, to which novelists and poets continually allude, which has left an abiding mark on the vocabularies of every language, and which supplies the material out of which dreams and the well-known hallucinations of sick people are built.

"To my astonishment, I found that *the great majority of the men of science to whom I first applied protested that mental imagery was unknown to them,* and they looked on me as fanciful and fantastic in supposing that the words 'mental imagery' really expressed what I believed everybody supposed them to mean. They had no more notion of its true nature than a color-blind man, who has not discerned his defect, has of the nature of color. . . . Much the same result followed inquiries made for me by a friend among members of the French Institute."

While men of science seem to have, usually, poor visual imagery, Galton found, people in "general society" frequently have remarkably distinct imagery. Children have more visual imagery than adults, and in general, women more than men. Galton was led to think that the visualizing faculty is inherited and that in all probability it varies among distinct races.

Since men of science employ but little visual imagery, the importance of mental pictures for mature thought would seem to be relatively insignificant. Processes of thought can be carried on so accurately and rapidly by aid of words rather than images of objects that the power of visualizing, if it was ever possessed by a given thinker, is likely to be lost by disuse—or at least subordinated to the use of verbal signs. This does not interfere with the ability to give lifelike descriptions of what they have seen. The line of inquiry which Galton initiated has been followed up by many extensive studies.

Kinds of Imagery.—We must not omit some reference to Charcot, the eminent French neurologist, who, before Galton, expressed the idea that individuals differ greatly in the extent to which they employ the imagery of the different sense departments. His work (largely in the abnormal field) as well as that of his pupils, gave strong support to the notion that many types of imagery are used, according to habit and natural tendency. "There are imaginations," says James, "not 'The Imagination,' and they must be studied in detail." Let us attempt to make some note of the imagery of the different sense departments, before undertaking a discussion of mental "types." For it is somewhat difficult to discover clean-cut types, although the fact of individual variation in imaginal emphasis of one sense department over another can scarcely be doubted.

The most conspicuous and easily detected variations as between individuals occur, as has been indicated, in the *visual* sphere. Some people have apparently little capacity to remember how things *look:* others profess themselves to be endowed with remarkable powers of visual recall and to be helpless without this imagery. The following statement by Mrs. Verrall shows the good visualizer:

"I find that I am able to call up a voluntary picture of an object or a scene with extreme distinctness. . . . The form is as well defined and the color appears as vivid in the visualization as in the real thing. I have endeavoured to ascertain whether form and color are equally well reproduced in the visualization, and as far as my own impression goes there is no difference. . . .

". . . I am able at any time to invest them with solidity by imagining that I see the real thing and not a memory or imagination picture. In that case they cast shadows, and I am able to realize distance.'' Mrs. Verrall, like other pronounced visualizers, tends to translate the perceptions of the other senses into visual imaginal form. ''At one time . . . I tried a longish series of experiments with cards with a view to seeing whether I could educate my sense of touch sufficiently to distinguish the cards after passing my thumbs once swiftly over the face of each card. I had some success; but the reason I record the experiment here is this: At first, while my attention was consciously directed to my fingers, I was aware that I could detect differences in smoothness of surface, which I learnt gradually to interpret; but after a couple of hundred trials, when I grew more expert and more familiar with the experiment, I lost all consciousness of the means which enabled me to guess, and 'saw' pictures of the cards which 'determined' the particular guess. This experiment seems to show that conclusions arrived at by other means are presented to my mind in the form of visual images, and suggests that sudden visual impressions, spontaneous as well as induced, may in my case be projected visually after they have been produced in some other way.''

Some individuals, on the other hand, testify that they have only the feeblest visual imagery and put little dependence on it. All of us talk of ''seeing'' things with the mind's eye, to be sure, but with some people it is probable that such imaginal seeing is like the blind man's seeing—it is touching, or hearing, or representing in terms of some other sense. Thus one of James' students: ''My ability to form mental images seems, from what I have studied of other people's images, to be defective, and somewhat peculiar. The process by which I seem to remember any particular event is not by a series of distinct images, but a sort of panorama, the faintest impressions of which are perceptible through a thick fog. I cannot shut my eyes and get a distinct image of anyone, although I thought I used to be able to a few years ago, and the faculty seems to have gradually slipped away. In my most vivid dreams, where the events appear like the most real facts, I am often troubled with a dimness of sight which causes the images to appear indistinct. To come to the question of the breakfast-table, there is nothing definite about it. Everything is vague. I cannot say *what* I see. I could not possibly count the chairs, but I happen to know that there are ten. I see nothing in detail. The chief thing is a general impression that I cannot tell exactly what I do see. The coloring is about the same, as far as I can recall it, only very much washed out. Perhaps the only color I can see at all distinctly is that of the table-cloth, and I could probably see the color of the wall-paper if I could remember what color it was.''

It is difficult, to be sure, to go back of the words and to estimate the real differences in conscious terms between the experiences of folk who give such widely differing reports. That some people do, however, place considerable or almost exclusive reliance on visual imagery is demonstrated by certain pathological cases. Charcot's classical instance supplies a good illustration.

''M. X. enjoyed until a year ago an equally remarkable memory. . . . His *mental vision* gave him, as soon as he wished, the representation of the features of persons, the form and the color of things with as much distinctness and intensity, he asserts, as the reality itself.

''If he were looking for a fact, a number mentioned in his voluminous correspondence, which was written in several languages, he found it again immediately in the letters themselves, which appeared to him in their exact purport, with the smallest details, irregularities and erasures in their wording.''

M. X., during a crucial period in his business life, felt a sudden change come over him. He lost his wholly remarkable power of visualization. He was able, however, gradually to replace his former visual imagery by other types. But he never recovered the phenomenal memory which was his so long as he was able to re-present objects in visual terms.

Auditory imagery shows the same variations from individual to individual, although its manifestations are less striking. Auditory hallucinations assure us of the intensity of reproduction which sounds may achieve on occasion. A few individuals report themselves as able to image sounds with the greatest ease and facility; they seem to *depend* on sound in their recollections. A great many people, on the other hand, are unable to recall voices, the sounds of instruments, the characteristic noises made by moving objects.

"It is plain," says Binet, "that the *pure auditif*, seeking to develop only one of his faculties, is capable of accomplishing, like the *visuel,* regular feats of memory; for example, Mozart noting down from memory, after two hearings, the *Miserere* of the Sistine Chapel; deaf Beethoven composing huge symphonies and repeating them to himself internally. By way of compensation, the *auditif,* like the *visuel,* is exposed to serious dangers; for if he lose his auditory images, he is left resourceless; he is completely bankrupt."

Kinæsthetic Images and the *tactile* images associated with movements seem to play a much more important rôle in the minds of some people than others of us would suspect. The introspective examination of kinæsthetic imagery is difficult because, in the first place, images of movements occur almost invariably in association with other imagery and, again, because any *thought* of a movement is likely to cause a motor discharge that produces kinæsthetic sensations. "It is well known," says Beaunis, "that the idea of a movement suffices to produce the movement or make it tend to be produced.'' As a consequence the inexperienced introspectionist is likely to confuse kinæsthetic imagery with kinæsthetic sensations. Titchener suggests a criterion by which they may be distinguished. ''Actual movement,'' says Titchener, ''always brings into play more muscles than are necessary, while ideal movement is confined to the precise group of muscles concerned. You will notice the difference at once—provided that you have kinæsthetic images—if you compare an actual nod of the head with the mental nod that signifies assent to an argument, or the actual frown and wrinkling of the forehead with the mental frown that signifies perplexity. The sensed nod and frown are coarse and rough in outline; the imaged nod and frown are cleanly and delicately traced.'' It is quite likely, also, that kinæsthetic imagery is often ''ejected'' into the objects with which movements are concerned: a book, for instance, may have *heaviness* referred to it and experienced as somehow in and belonging to it. But this remark will probably mean little except to such as are motor-minded.

It seems certain, however, that in recalling objects many people apprehend them in motor terms. Each and every object, of course, calls for its own unique form of motor reaction; calls into play a characteristic group of muscles. It is easy to understand how the individual, in imagining, may strike the motor attitude relevant to the object signified. Strickler, of Vienna, gives us an account, now considered classical, of the motor type of individual. He himself was so predominantly motor in type as to be unable to understand, apparently, how anybody could dispense with kinæsthetic imagery. The movements involved in articulate speech seem to have played a very important part in his mental life. There is good reason to believe that kinæsthetic imagery (combined, it may be, with incipiently aroused kinæsthetic sensations) is an important constituent in the mental life of most people, and that it bulks unusually large for some. Consider, for instance, what must be the difference between a person who, in thinking of a soldier marching, beholds a visual representation in action, he himself remaining a detached spectator of the scene, and one who, like Strickler, feels the *movements* of marching, and participates actively in the performance. Surely it is in this circumstance that differences in *temperament* find at least a part of their explanation.

Images of **smell** and **taste** do not play an important part, apparently, in the thinking of the normal person. There are exceptions. It is said, for instance, that the novelist Zola could recall odors with great facility. Every object had for him its distinctive smell; every town and street. He thought "autumn" in terms of the odors of mushrooms and decaying leaves. His olfactory imagery seems to have been much clearer than that of any other of his senses. His case, however, is exceptional. Smell and taste are not important senses in civilized life. It would seem that children—and savages (how often do we thus connect children and savages in our remarks!)—make much more of these senses than do civilized adults. While cases of the pronounced use of olfactory and gustatory imagery are not common, it may be that most individuals can, upon occasion, imagine distinctive odors with at least a fair degree of intensity. This normal expectation has been confirmed in a number of experimental inquiries.

Verbal Imagery.—A great many individuals image, in place of concrete objects, the *words* which symbolize them. Their thinking is carried by imaged words, as the quotation from Galton (above) fully indicates. Words are the representatives of things, and in the forum of the mind may stand as their proxies. Now we may imagine words in several ways: chiefly, by seeing them written, hearing them spoken, or by giving them incipient utterance (kinæsthetic reproduction). The motor-verbal type is, without doubt, the most prevalent. Strickler, who was of this type, says that his words are reproduced as suppressed whisper, with incipient innervation of the speech organs. Certain behaviorists, of late, have insisted that thinking is carried on entirely in the form of suppressed verbal articulation. Many people, however, reproduce their words in auditory terms, and it seems probable that some imagine their words in the form of printed or written characters.

Types of Imagination.—While individuals vary greatly, as we have seen, in the degree to which they employ the imagery of the various senses, it is somewhat difficult, nevertheless, to classify people into imaginal *types*. Professor Titchener, one of our foremost introspective students of the mind, furnishes us with the following tentative classification. ''Marked differences of imagery, as between one mind and another,'' he says, ''undoubtedly exist; but the distribution into types is made difficult by two facts. The first is that there are great differences in the nature of images even where the gross type is the same; thus, of two predominantly eye-minded persons, the one may have vivid and precise, the other vague and obscure images. The second is that imagery varies with the nature of the test made, the situation or material that arouses the images; in strictness, we can say only that, under such-and-such conditions, the imaginal type proved to be such-and-such. With these cautions before us, we can, however, make out four common types. The *versatile* type uses visual, auditory and verbal-motor images more or less indifferently. A second type prefers *visual* images, with verbal-motor a good second. A third type prefers *verbal images of the auditory-motor kind,* with visual images a poor second. A fourth is almost exclusively *verbal-motor*. In this last type, kinaesthesis, in the special form of the feel of articulation, has reconquered the place that it held in the long-gone past, before speech had come.''

The *practical consequences* of differences in imagery as between individuals have been widely discussed, especially in the educational field. For it is held that a given subject-matter can be best memorized by a student in terms of his favored sensory department. In the writing of advertisements, in novel writing and speech-making, wherever ideas are to be communicated, it has been held important to consider the various ways in which individuals are impressed in consequence of their peculiarities in imaginal type.

This is exaggerated, however. At any rate there is no evidence of loss entailed by the *visuel* due to his stimulation by auditory means. Such stimulation *immediately* arouses his visual imagery; and there is no good evidence of gain arising from visual excitation.

Fancy.—So much for the materials with which imagination works. We may now go on to record whatever may advisedly be said concerning imagination in its active aspects. Our lighter modes of thought have never been the objects of serious scientific scrutiny—nor even of close general observation. The average psychological treatise never smiles; it must forever tell us that ''life is real, life is earnest.'' Our Castles in Spain—what has science to do with such trifles? Fairy-land and wonder-stories, the myths of Greece and Norseland, the conceits of poets traced in imagery of spun moon-shine, the enraptured visions of mystics—what, we ask, has science to do with these things unless it can show how they *bear* upon real life? And so we leave them to our own lighter hours, outside the workshop. In this we acknowledge that imagination is very largely a play activity, having no end, apparently, beyond itself, unless it be admitted to possess, like certain well-known medicines, a tonic value directly proportional to the pleasure it gives us.

In common life the tight-hooped individual who keeps his mental processes clamped firmly together, with never a play of wit nor vagary of allusion, is quite rightly an object of suspicion. *Wit and humor* are, psychologically considered, forms of associative play. Locke had the essence of the matter. "Wit lies most in the assemblage of ideas, and putting these together with quickness and variety, wherein can be found any resemblance or congruity, thereby to make up pleasant pictures and agreeable visions in the fancy. . . ." Locke, like many another philosopher, thought wit a matter of small importance. But perhaps he, too, took human nature too seriously and practically.

Wordsworth's comments on the nature of fancy are well worth quoting.

"The law under which the processes of Fancy are carried on is as capricious as the accidents of things, and the effects are as surprising, playful, ludicrous, amusing, tender, or pathetic, as the objects happen to be appositely produced or fortunately combined. Fancy depends upon the rapidity and profusion with which she scatters her thoughts and images; trusting that their number, and the felicity with which they are linked together, will make amends for the want of individual value: or she prides herself upon the curious subtilty and the successful elaboration with which she can detect their lurking affinities. . . . Yet it is not the less true that Fancy, as she is an active, is also, under her own laws and in her own spirit, a creative faculty."

It would be as useless to inquire why such performances please us as to ask why we like sunshine. We like them, and there's an end to the matter. "The peculiar characteristic of this superfluous activity," says Ribot, "this form of play, is the fact of its spending itself *in a combination of images and ending in a creation which has its aim in itself;* for creative imagination sometimes has practical utility as its aim. It differs from the other forms of play only in the materials employed and the direction followed. We may say, more briefly, that it is the play of creative imagination in its disinterested form."

Fanciful Constructions.—It is the fact that many people—how many we can only guess—build for themselves fairylands of imagination which rival in reality and consistency the world of practical activity. We recognize that such constructions are altogether natural in childhood. Galton remarks that there are probably some children who pass years of difficulty in distinguishing between the objective and subjective worlds. And how children do love myths, and tales of marvelous and impossible things, and Alice-in-Wonderlands! Sometimes this play of fancy is continued into adult life with unabated vigor, but there its propriety is as dubious as its healthfulness.

Where life is kept in normal poise by purposive contact with the world, such subjective "secondary continua" seem to work no harm. On the contrary, the creative mind seems to be endowed with the associative plasticity which makes just such constructions likely. Hence it is that the cultivation of the imagination is often advised. Thus Miller: "Through play, myth, and fairy story the imagination of the child is called forth and exercised. It is given flexibility and power. It receives practice in the organization and use of imagery, which is important for every phase of the higher psychical processes. The first mental wholes are built up which serve as the basis for further analyses and syntheses on which higher development depends."

It is certain that geniuses have frequently, if not always, unusual powers of imagination. Says Lamartine: "Ce n'est pas moi qui pense; ce sont mes idées qui pensent pour moi." Lombroso, in his work on *The Man of Genius,* demonstrates—whatever may be said for certain of his theories—that vivid imaginal experience is characteristic of the super-normal man. Among geniuses imagination frequently approaches hallucinatory vividness. It is perhaps even more signficant that such imaginal experiences are not chaotic and disjointed, as if they were the phantasies of the automatic centers running loose, but rather coherent and significant. Old forms of thought take on new and richer groupings; far-fetched resemblances develop into fruitful connections. In such movements imagination is continuous and persistent, not fitful and transient. Swedenborg's Heaven and Dante's Inferno take on the aspect of reality itself—presenting themselves as very genuine possibilities. And from such topics to practically motivated Utopias is no more than half a step. Wordsworth, in *The Prelude,* does not overestimate the importance and urgency of imagination for the creative artist.

"Imagination—here the Power so called
Through sad incompetence of human speech,
That awful Power rose from the mind's abyss
Like an unfathomed vapor that enwraps,
At once, some lonely traveler. I was lost;
Halted without an effort to break through;
But to my conscious soul I now can say—
'I recognize thy glory:' in such strength
Of usurpation, when the light of sense
Goes out, but with a flash that has revealed
The invisible world, doth greatness make abode. . . ."

Dreams.—Dreams are, because of their nature, associated in our thought with fanciful constructions. They are, as a matter of fact, of the same stuff. They have been discussed in an earlier chapter in connection with hallucinations, however, where, indeed, they more properly belong.

Imagination and Reality.—While we recognize the importance and the value of the work of the imagination, we are forced to believe that its unlimited exercise is attended by unusual dangers. For imagination, we commonly think, with whatever justification, is the door-way to madness or at least to dreamy impracticality. That there is sound justification for this opinion modern psychology has abundantly demonstrated. Dallas quotes the following example of imagination run to seed. "Sir James Mackintosh was a man who mixed much in the world and took a forward part in public affairs; but from his youth upwards he led another life of curious reverie. He was the emperor of Constantinople, his friends were his ministers and generals. In endless day-dreams he saw transacted the history of his empire, he watched the intrigues of his palace, he gave rewards to his faithful servants, and formed alliances with neighboring Powers." It is only a step from a condition of this kind, where a dream-world exists concomitantly with the real world—its rival, in a sense—to a state of mind in which the dream-world comes into the ascendant and contracts waking life to the smallest area consistent with the maintenance of existence. This, Janet explains, is what occurs in hysterical cases of the type accompanied by pronounced anaesthesia. The hysteric takes in only so much sensation as is necessary for the support of life; all else is excluded. "One must needs have consciousness of what one sees and hears, and so the patient neglects to perceive the tactile and muscular sensations with which he thinks he can manage to dispense. At first he could perhaps turn his attention to them, and recover them at least momentarily within the field of personal perception. But the occasion does not present itself, and the *psychological* bad habit is formed. . . . One day the patient—for he is now veritably a patient—is examined by the doctor. His left arm is pinched, and he is asked whether he feels the pinch. To his surprise the patient realizes that he can no longer feel consciously, can no longer bring back into his personal perceptions sensations which he has neglected too long—he has become anæsthetic. . . . Hysterical anæsthesia is thus a fixed and perpetual distraction, which renders its subjects incapable of attaching certain sensations to their personality; it is a restriction of the conscious field.''

We have said that it is but a step from the condition of Sir James as described above to a state in which the dream world is in the ascendant. It is less than a step from the same condition to the delusion of grandeur, and from an analogous status to the delusion of persecution. Indeed the picture that is presented in the foregoing description is that of one who is suffering from an insane delusion.

We thus find that mental unbalance and perturbation of the type described is induced by a *withdrawal from reality.* There is no remedy for these morbid states except through a return to the world of natural forces and concrete problems. What we often call ''too much imagination'' might as well be called ''too little sense.'' The senses give stability to our mental life. They furnish the materials for solid foundations and for the repair and correction of the super-structure.

The Healthy Imagination.—There is nothing about the imagination *per se* that makes it dangerous; imagination, indeed, is never the *cause* of mental aberration, but is always a prompt indicator of such disturbance. Any form of mental abnormality is sure to show itself first in the more delicate tissues of the mind. This opinion is widely affirmed by psychologists.

The basic structures of personality must be sound in order to support effective imaginative processes. Exception to this statement might be made in the case of certain geniuses whose mental constitution seems precarious of balance. On the whole, however, there is undoubtedly much truth in the widely adopted opinion that the physical and sensitive nature must be sound and vigorous in order to sustain productive intelligence. Given this, a healthy imagination usually follows. It is the universal practice in modern medicine—including psychiatry—to seek the cure for imaginative disorder in the readjustment of the fundamental functions of the organism.

But we also have, it must be admitted, forms of mental healing which aim at the cure of physical or at least functional disorders through the exercise and extension of the imaginative powers. Some of the results achieved in this way seem rather startling. We cannot speak with any confidence concerning such matters because no systematic studies have been made of the inner movements and forces released by the stimuli presented. The most that can be said with any assurance, at present, is that certain exercises of the imagination produce a mental *relaxation* which seems to favor functional readjustment. We may recur here, once more, to the fact that a certain freedom of imaginative play is pre-requisite to mental growth and stability. It is likely that wit, humor, fancy and imaginative art provide just that mental relaxation which seems so important for sane living. "Mental healing," in so far as it follows or improves upon this natural prescription, would seem to be on the way towards success. On the whole, we must conclude, the use of the imagination is relevant to the total organic life of which it is an aspect. The various parts of our nature so interpenetrate one another that whatever affects any one function must also affect others.

The Scientific Imagination.—So much for imagination in what we may call its æsthetic aspects. We find it more significant, practically, in connection with reasoning and scientific construction. The "world," as we know it, is in large measure a construct of the imagination. Who has ever experienced, sensationally, his state, his nation, his earth, his universe? These total objects exist for us, not as perceptions, but as works of the imagination. Insofar as we reckon with the *absent* in an effective way we must think it in order and sequence. Now most of the items that go to make up our worlds can be presented to us, in any given instant, only through images or imaginative reproduction. It is essential, therefore, if action and reflection are to prosper, that these images should be woven into an organized system of experience. There is no special activity of the imagination by which this end is achieved. *All* of our conscious processes, indeed, work towards the establishment and maintenance of an effectively organized experience. We here call attention merely to the circumstance that the individual's total experience is a construction in which images—as contrasted with sensations—play a predominant rôle. And there are some considerations of a general nature that may well be taken up before we enter into a specific discussion of the higher constructive processes of thought.

The world as imaged by the common-sense man, who is unacquainted with the higher flights of science is an *action* world, and its organization follows the lines of his projected activities: the world, that is, in so far as it is conceived as "real." The association of ideas here may very well be translated into motor terms as the concomitant of our organized habit-systems.

What relationship does such a practical and direct organization of experience bear to the highly logical and sophisticated constructions of scientific thought? The former is natural and inevitable; the latter deliberate and studied. The former is in terms of response and adjustment; the latter is conceived through abstract relationships reflectively formulated. The physical universe of a Newton, for instance, would seem to form an imaginative system somewhat disconnected from the ordinary world of practice; most persons, at any rate, would find it very difficult to assimilate the two to one another.

Objective Constructions.—Even our worlds of practical action, of course, do overlap and coincide. We think of the everyday world of things as quite independent of the thinking of any particular individual. However imaginative such a world may be from the point of view of thought, it is, nevertheless, of such nature that imaginative construction must follow its outlines or prove ineffective. We must *think* in order to act coöperatively with our neighbors.

Now a scientific construction, to be valid, must likewise be true to the "real" nature of things. It amounts to no more, properly understood, than an extension, in depth and breadth, of our ordinary views of the world. It aims to be as completely *objective* as possible. Newton's physical universe must be thought of as an extension of the world of our everyday experience, and like it "real" for everybody. Indeed, it must, if it is to be justified, in the long run make practical action more effective and farther-reaching. The same condition holds true for any scientific or metaphysical system which is to be regarded as valid and not a mere work of fancy.

Certain scientific views of the nature of things are, to be sure, abstract and partial. It is somewhat difficult to grasp the connection between a world of ions and electrons and the world of potatoes and politics. The scientific system often appears to be relatively isolated. This, probably, is because so many scientific systems are provisional and tentative. We adopt a certain scheme for representing things to ourselves in order that we may, if possible, bring them under intellectual control. But in the long run the abstract view, if it is to be considered valid, must be assimilable to the total world of our organized experience.

Our imaginative construction of the world, then, must be objective, in the sense of conforming to the real nature of things, and again as being shareable by all who think consistently. Such worlds are coöperative representations of the real. Now the great instrument of coöperation is language, including under this head all standardized forms of symbols. Any one individual might build up in his own imagination a representation of the universe that should be wholly logical and orderly within itself. But such a construct would be *scientific* only to the extent that it could be thought by others *with the same results.* Hence the higher thought processes presuppose language and thought as essential conditions.

The Scientist's Use of Imagery.—The scientist, therefore, may and does employ imagery in much the same fashion as does the poet—but his use of it is more rigid and exacting. The poet, it will be justly said, must speak in universal terms, but it may very well be his object to *please* by his artistic constructions, whereas the scientist proposes to "discover the laws of nature." The latter uses his imagery as a means to an end, never as an end in itself, and his object is always the discovery of truth concerning the nature of things. He will try to imagine things as they really are or as they possibly may be. Hence images stand for him as representatives of real things considered in their objective bearings upon one another.

The scientist, in other words, engages in *ideal experiment.* He tries objects in various relationships and groupings, scrutinizes them for hidden connections, looks afar for resemblances which are not immediately given. He brings lightning into relationship to the electric spark, these into connection with the phenomena of induction, thence onward to characteristics of heat and light, seeking ever wider and more inclusive formulations. The experiments of the inventor of a cotton gin, a reaper, sewing machine, an internal combustion motor, or what not, are wholly analogous. In such processes imagination is indispensable; but it must be rigidly controlled.

It is not at all necessary, as we have seen, that the scientist employ visual imagery in his ideal experimentation. It is required only that he be able to reckon with absent facts in some effective way. It is probable that verbal-motor imagery will in most cases prove sufficient: standarized words, symbols, may very well replace concrete re-presentation. But no doubt there are here, as elsewhere in the sphere of imagination, very extensive differences in individual habit and preference. We may venture, in this connection, to suggest that imagery becomes more concrete and specific in type in accordance with the novelty of the problem that confronts the inquirer. Thus a student who is not familiar with the law of falling bodies may be compelled to resort to very concrete images in order to recollect and apply its formulæ, whereas a master physicist will use the law effectively with a minimum of representation, and that of the most generalized type. In the case of most people, it would seem, imagery becomes most clear, detailed, and intense in situations where some problem forces us to take a *new* view of things—aside from the paths of established habits of thought.

Imagery and Concepts.—We are to learn in the next chapter that thinking, above the level of perceptual adjustment, is in general or universal terms. We generalize, conceive, reason in "abstract" terms. Now our abstract thought is made possible by *concepts,* or general ideas. Thus "chair" is a class name, which may be applied to any one of the innumerable objects which belong to the class, and with equal propriety to each of them. "Force," "Matter," are still more abstract concepts. Now when we think conceptually, as when we think about "weight," *in se,* what kind of imagery do we have?

Images, it would appear, are always particular. Thus when I think "house"' I may image to myself some *one* house—but can I image *house in general?* Do we, in other words, have generalized images. Certain writers are of the opinion that we do, or must have. Thus, in thinking "house" I must have an image which is neither of a colonial house, a bungalow, or a stone cottage, but an image which is a sort of composite of all of them, and which refers equally well to all. Modern introspective studies, however, show that thought may very well proceed without such generalized images. The image of a particular house will carry the general meaning intended as well as a composite or generalized image. Concepts, we shall find, are *meanings,* and as such distinguishable from presentations. But we must defer the discussion of this most fascinating albeit perplexing topic to our next chapter.

CHAPTER X

CONCEPTUAL THOUGHT

> "The sensible appearance is individual and evanescent: the permanent in it is discovered by reflection. Nature shows us a countless number of individual forms and phenomena. Into this variety we feel a need of introducing unity: we compare, consequently, and try to find the universal of each single case."—HEGEL

In the first place, in our discussion of the subject of this chapter, we must attend to the conditions that must be at hand in order that a thinking process may be set going. In doing so we shall be trying to understand the tools of the thinker: concepts and meanings.

Conception and Perception.—To perceive a thing, we have said, is to bring the sensory process to bear upon it in such fashion as to "make it out." The perceived object is present to sense and to that extent immediately or directly apprehended. Perceiving, however, and indeed all of the conscious processes, has another aspect which we must discuss under the head of Conception. We must remind ourselves, once more, that consciousness is a unified, a single, process, whose various phases, as shown under differing circumstances, we are discussing under separate topics and in separate chapters. If, then, we discuss "conceptional thought," our reference is to the same conscious activity that we have examined heretofore, but that we are now viewing from another of its many sides. It is of particular importance that we should observe here the relationship between perception and conception, for they are often falsely represented as separate "faculties" or powers of the mind.

What does it mean to *conceive* an object? **To conceive an object is to apprehend it in its relationships to other facts of experience.** Thus, we have a conception of radium when we can tell something about its qualities as a substance, the peculiar phenomena which it manifests, its place in the scientific scheme of things. We know it as a substance *among* substances, its phenomena as related to other physical phenomena. To conceive a thing is to know it in its relationships. It is the relational aspect of objects that comes to the fore when we discuss conceptual thought, whereas in studying perception our attention is upon objects *in se;* upon their uniqueness and individuality.

The problem of conception, then, is the problem of how we represent or think relationships. But this is the *logical* formulation of the problem. Psychologists, in considering this topic, translate it into the question, How do we think *meanings?* Meanings are relationships as experienced—rather than as thought about. The meaning of any word must, of course, be rendered in conceptional terms. What does "pita" mean? Pita is a plant, growing in the Malay archipelago, which produces a fine fiber suitable for weaving. Thus meaning is always given in terms of the relationships which an object bears to other objects of our experience. But, as occurring *in the thought process,* these relational elements are called meanings.

Concepts and Meanings.—Concept, as we commonly use the term, is a meaning or mode of relationship carried by a *word.* The word, in this case, is a standardized symbol, which denotes a fixed meaning. Not all meanings, however, are thus objectified and standardized, so that they may be denoted by language. Meaning is elementary, fundamental, and exists wherever there is thought, regardless of the *level* of the thought process.

Romanes observed that animals have *recepts,* which are, in a manner of speaking, embryo concepts. Thus birds do not alight upon water as they would upon land, but have generalized modes of response appropriate to *kinds* of things, which guide their activities. Water, we may say, means for the bird, *alight in this way,* whereas land or ice means something different. Here, of course, the relationship in view is that between object and action; meaning is in terms of response. Some thinkers have contended that all relations ultimately reduce to terms of reactions to things. But however that may be it is clear that the birds *place* objects, and do not react to them merely as so many *that's.*

Mankind has something comparable to recepts at the level of mere perceptual response. We learn the meanings of objects in terms of our reactions to them, and in terms of their relationships to one another, where frequently we cannot isolate the meanings and give them names. Who, for instance, can tell all that a slippery side-walk *means* to him, or express all that he apprehends about the relationships between a bull pup and the family cat? We say of an individual that he is a "quick thinker," because in playing ball his reactions are prompt and appropriate. He thinks, indeed, and grasps the meanings of things, even though he could not express the meaning thus apprehended —in words. A quick thinker, in this sense, may be unutterably stupid in a mathematics class, or in any pursuit where *standardized* meanings are to be mastered or expressed. Meanings, then, are more fundamental than words; they are the warp of our experience, as feelings are the woof. This is only a way of saying, perhaps, that intelligent conduct is *appropriate;* that it is a response, not merely to individual facts, but to facts as related. There is order, system, in every phase of our experience. Our worlds of daily action, no less than our scientific worlds, are made up of *things related.* To be intelligent, as already defined, is to be able to conform to these relationships; to take cognizance of the way in which things bear upon one another including our own activities.

Concepts and Language.—Language is, of course, the indispensable instrument of our *higher* forms of thought. By means of words we objectify meanings in such wise that they may be apprehended and utilized by the *community.* The process by which meanings are thus transferred from the individual to the social sphere, and stabilized and fixed, is, indeed, an interesting one, and deserving of more study than it has received. Such a study would be largely historical in character, for our language has undergone a long and tedious process of development. The process of discovering meanings and standardizing them, of course, is still going forward, and may be investigated. Such a study, it may be said, belongs more immediately to *social* psychology than to general psychology. But it interests all of us. Thought *is* carried by language, and so closely are thought and words bound together that we habitually hold inferior verbal expression to be a mark of muddy thinking, and employ "vocabulary tests" to measure the intellectual level of individuals. It is certain that nobody, in the civilized sphere, and particularly in the field of science, can get very far who has not mastered the concepts in which our sophisticated thought is expressed.

Kinds of Concepts.—As we move from the common-sense level of thought up through the scientific sphere of reflection, we find concepts of varying degrees of "abstractness." *Class terms* are most universal and familiar. Many psychologists, indeed, seem to proceed upon the assumption that all our concepts are of this type. This, as we shall see in a moment, is an unjustified assumption. Class terms denote kinds, or classes of objects; things which, by reason of similarity of qualities, properties, or use, have the same general meanings for us. "Chair," for instance, is a class term, which denotes a class of objects, which have the same meaning for us in terms of *use.* Binet, in his studies of children, and of backward adults, discovered that the most primitive form of definition is given in terms of use. Thus: a knife—it is to cut with; ball, to throw with. A more advanced thinker will define by referring the knife to its *class,* and giving its differential characteristics. Some objects, such, for instance, as "planet," cannot be defined except in terms of some general *system* of science to which they belong. The definition of a plant, from a botanical point of view, must be formulated by reference to its relationships to other plants, as conceived in a general scheme of classification. But class terms, generally speaking, are *concrete,* in the sense of denoting classes of things that may be perceived. Concrete qualities, also, such as redness or hardness, may be treated as classes. It is probably an error to conceive of redness as a particular thing or entity. Likewise with other qualities and properties of things which we discriminate.

There are concepts, however, which are once and for all abstract. *Force* and *mass* are such terms. These are not things, and have no semblance of thinghood; nor are they classes of things or qualities. Force, for instance, has no scientific—as distinct from common-sense—meaning, outside the system of physical science. It is a formula which, within the general system, expresses a certain set of *relationships.* Its whole meaning, indeed, is that of a typical relationship which has almost universal applicability to physical bodies.

In the moral sphere *justice,* and in the religious, spirituality, are likewise abstract concepts applicable to a multitude of relationships, although they designate no single entities, qualities, or properties. One of the greatest difficulties that young students face is that of thinking such concepts in relational, rather than concrete terms. Our tendency is to think of force and justice as things; we *hypostatize.*

Hypostatization and *anthropomorphization* (we are *not* responsible for the terms) are tendencies of thought so primitive and so universal that we could call them "instinctive" and be no farther removed from the truth than we are when we speak—for instance—of the "gregarious instinct." Hypostatization is the ground error of the materialist. He erects force and matter (matter is a highly abstract term) into real entities, reifies the "laws" of physical science, and declares these entities to be universe's fundamental realities. The spiritualist, at the other extreme, reads his own consciousness into all nature, makes *spirit* the all-inclusive reality, and reduces the solid objects of our perception to mere "appearances." Such errors need not arise, if it be considered that these concepts stand, not for individual reals, but for relationships and forms of organization. It is chiefly in their universality, their range of extension or reference, that the most general concepts differ from those more concrete. A concept, as such, always denotes relationships among objects of our experience.

Logic and Conceptual Thought.—Logic is an old science, first formulated by Aristotle. Logic deals preeminently with concepts, and with the types of relationships which we develop and employ in the reasoning process. It is, in a sense, a digest and formulation of the methods of science—if we use the term science in its widest sense to denote all systematic forms of inquiry into the nature of things. Logic, however, has traditionally dealt with thought in its *formal* aspects. With the individual thinking process, as such, it has little to do. It treats of categories, methods, conceptual constructions; it is occupied with the general modes in which we express and confirm relationships between things, by classifying things, discovering causes, or developing organized systems.

Now logic and psychology are not absolutely separable in the field of the higher thought processes. They frequently overlap. Practically, however, the two sciences are distinguished by marked differences in approach and methods of procedure. Psychology is occupied here, as always, with the *nature* of the conscious process, in its individual manifestations. It aims to describe the conceptual processes; tell what they are as they occur, and how they proceed from origin to termination. Logic, however, is interested in thought *in general,* its aim being to discover the means by which truth is attained. We may perhaps express the difference between the two sciences by saying that logic is interested in knowing what formal steps thought must take in order to reach correct conclusions, whereas psychology is bent on examining the *stream* of consciousness by which this logical procedure is carried forward. Logic deals with thought in its objective character, psychology investigates its inwardness; logic finds its chief materials in the formulated methods of the sciences, psychology observes thought in its own movement. But, in the end, it will be found that the two sciences tend to fuse, as if they were separate divisions of one and the same inquiry. It is best to regard them so, rather than to force a division to suit the convenience of our university departments. In this account of conceptual thought, however, we shall try to adopt the mode of approaching the study of conceptual thought that is characteristic of psychological procedure.

The Psychology of Meaning.—Within recent years introspective psychologists have undertaken the study of meaning by experimental methods. This research, although it has not progressed very far, holds promise of interesting results. The principal question that has occupied the introspectionists is this: is it possible to *think* meanings without the aid of images? The psychologist who believes that thought is nothing more than a stream of ideas and impressions that drift parallel to the processes of the nervous system, is not likely to find any "imageless thought." Those, on the other hand, who hold a functional view of the mind, are apt to be assured in advance of experiment that there are imageless thought processes. But the meaning of a word or object may very well be understood without reference to images *that appear in introspection.* How, then, *is* meaning experienced?

A hammer, as perceived, *means* certain activities. We conceive it as an object to be used in certain ways and as having a certain place in our scheme of things. But the meaning, unless we expressly stop to reflect upon it, is not *thought about* when we perceive the object. We do not perceive object *plus* meaning, as if we had two things before us. The object is, as perceived, a such-and-such *object;* the thing's meaning is somehow embodied in it in such a way that it is indistinguishable by itself. But this embodied meaning gives the object the *character* that it possesses as an object of experience. Meaning and existence are as inseparable as "wax" and "shape": for wax, in order to be wax, must have *some* shape, and in order to be an experience an object must have *some* meaning.

A great many investigators appear to have fallen, here, into the "psychologist's fallacy." They reason in this wise: I hear a sound, which, as it comes, is a mere auditory sensation. This sound calls up associations which, as they develop, give me the meaning of the sensation—"somebody knocking at the door." In this scheme of things we are first given sensations, to which meanings (in the form of associates), are afterwards added. Now there are situations in which something comparable to this might happen. Our ordinary experience, however, shows nothing of the kind. We directly and immediately experience somebody-knocking-at-the-door. The sound *arrives* with its meaning already developed. In the typical situation the meaning of the thing is not experienced after it, nor apart from it, nor is it, strictly speaking, distinguishable *in* it. Every object, in an ordinary experience, is, as object, as much a meaning as it is an existence. We speak abstractly, and with deliberate sophistication, when we refer to any image, sensation, percept, emotion, object—as *having* meaning. The meaning is an inseparable aspect of the thing's existence.

This, in the long run, is only a way of saying that every object *is* an object of our experience, and as such related to other objects and to our activities. We apprehend an object, directly, not as an isolated, unique, self-contained thing, but as a thing related to other things. The object's relations to other things give it the character that it has. There is nothing, in our experience, that is not thus placed by us, which is not *experienced as* related to other things. In all this there is no mystery, so long as we do not fall into the error of supposing that things can be experienced as self-contained entities. This never happens. A sound, for instance, that is not related to other sounds, that is not like something heard or sensed before, that stands, as it seems, in lonely isolation from all past and present things —well, there are no such sounds. We see, then, that meaning is an intrinsic aspect of each and every item of our experience: that aspect, namely, in virtue of which it is a *somewhat* instead of an absolutely unrelated *that*.

When Are We Interested in Meanings?—What we have just been saying, however, applies only to objects as met with in the ordinary course of experience. Here meaning, we have said, is so embodied in the object that it cannot be torn loose from it and viewed in abstraction. We get a better understanding of the nature of meaning by reference to those situations in experience where the meaning of an object is *explicitly sought after*. We hear, for example, a noise. What is it? Observe that in this case the *character* of the noise is such as to cause us to direct attention upon it.

We seek to know the meanings of things whenever the nature of the object (as expressed in its bearings, consequences, implications) is not clear; when, as a consequence, we direct attention upon it in order to "make it out." It is under such conditions, and such only, that we can be said to be interested in the meaning, the significance and import of the thing, in such wise as to make the meaning a direct object of investigation.

In our chapter on Attention it was made clear that we attend to things which bear, in some fashion, upon our interests. And, further, that we attend to interesting things when, from the standpoint of some purpose, implicit or explicit, they constitute a *problem*. We are now in a position to see that any such problem can be expressed in terms of meaning; that is, a conscious process has always before it the determination of the implications or bearings of the problematical object. This statement will hold for any kind of problem, from the most concrete to the most abstract.

Let us return to the instance of the strange noise. The character of the noise is such that, in this time and place, under these conditions and in relation to these purposes, it constitutes a problem, in the sense that we cannot make out what *kind* of thing it is; how it is related to the general situation which confronts us. We put our attention upon it. We begin an investigation. Thus all thought processes originate and strive toward the development of the meanings of objects. It will be understood that in such a situation the problematical thing is not *utterly* meaningless. This, we have said, is impossible. The sound is recognized as of this or that pitch or volume or timbre, as like this or that sound that we have heard. It has *some* associations. But its meaning is not *adequate for the occasion.* Its implications must be more fully developed from the standpoint of the present situation. Thus any conscious process is an activity whereby the meanings or relationships of an object are developed in accordance with the demands of the problematical situation which calls consciousness into operation.

Meaning and Anticipation.—We said, in an earlier chapter, that conscious behavior is *anticipatory.* We are to understand, in the present connection, that anticipation occurs *as meaning.* For the meaning of a thing is rendered, as we discover in the process of "making it out," in terms of possibilities, consequences, expectations.

Thus meaning, at least for the perceptual situation, is the *future in the present.* Is this statement difficult to understand? We have had no hesitancy in saying that the past lives in the present. Is it not equally rational to hold that a bit of the future resides in every conscious moment? Let us consider that, as a matter of fact, we *do* anticipate. We do hope, expect, fear, plan, and prophesy. On what grounds? Only because *objects bode forth their possibilities.* Because their potentialities, as bearing upon our purposes, are inscribed in their very appearances, as the characters of men are expressed in their faces. This meaning, this embodiment of future consequences, is inseparably bound up with the existence of every experienced fact. Nobody has given this truth better expression than Professor Bode. "This control by a future that is made present," he says, "is what constitutes consciousness. A living body may respond to an actual cut by a knife on purely mechanical or reflex principles; but to respond to a cut by anticipation, i.e., to behave with reference to a merely possible or future injury, is manifestly an exhibition of intelligence. Not that there need be any conscious reference to the future as future in the act. Merely to see the object as 'sharp' is sufficient to give direction to conduct. But sharp is equivalent to 'will cut'; the quality of sharpness is a translation of future possibility into terms of present fact, and as thus translated the future possibility becomes a factor in the control of behavior. Perception, therefore, is a point where present and future coincide. What the object *will* do is, in itself, just a contingency, an abstract possibility, but in perception this possibility clothes itself in the garments of present, concrete fact and thus provides the organism with a different environment."

This statement was intended to be taken literally. It will stand, moreover, the keenest empirical test. Have you ever picked up an object that looked heavy and been surprised the next moment to find it light? The object did not live up to its *promises.* It predicted heaviness—it turned out to be light. The organism was set for a heavy object and the resulting experience was confusing. What could demonstrate more conclusively that things *do* embody their meanings in the form of consequences? *We set ourselves for everything that we perceive.* In any case of error we should experience the same confusion that arose in the case cited. Our behavior is always a pace ahead of our actual movements—when we are conscious. We are forever *preparing* our acts in advance of their emergence. The same statement holds not alone for perception but for any kind of conscious experience whatever. To be conscious is to anticipate.

How Meanings are Developed.—And now let us return to the situation in which we make out the meaning of an object. We do this, we said, whenever the meaning is not adequate. But how does the object come to appear inadequate? How does it signify its lack of appropriate meaning?

This subject needs experimental study. We may secure the best understanding, surely, by regarding meaning again in terms of future consequences. An object whose bearings, in a given situation, are not assured, is one to which we cannot secure an adequate preparatory adjustment. We notice *this* sound because, in this situation, the thing is an uncertain quantity with respect to its future implications. We do not quite know how to "take it," or do not understand what kind of reaction it calls for.

It should be observed that we never adjust ourselves to any object as a thing in itself, but always with reference to it as an element in a situation. That is where its relationships come into play. We do not react to the bear in the cage as we would to the same bear met in the woods. The same is true in the case of the strange sound. In *this* situation the sound is attended to; in another it might be wholly neglected. In this situation the sound is a real factor in the situation; it threatens or promises something in the way of consequences. It is the same with any problematical object. How, for instance, will the troubles in the Ruhr affect my proposed investment in stocks? The Ruhr difficulties demand attention because they constitute an uncertain factor with respect to my business affairs.

It is on this basis that we always attack a problem in meaning. We are not interested in the *absolute* meaning of the object (if there be any such thing) but in its bearings in some specific situation or in relation to some defined purpose. And this initial generation of the problem governs its solution. We investigate the object, try to understand its import and bearings, in terms of its potentialities in reference to the specific situation presented. We study, not the object in itself, but the object as a factor bearing upon other elements in this specific experience. Otherwise we should go widely astray, and never arrive at a solution.

The Critics of this View.—Psychologists opposed to this view hold that psychology is not *concerned* with the meanings of things. It is interested, on the contrary, in the description and analysis of states of consciousness, as such. This standpoint is only possible, of course, to one who holds the theory that *existence* and *meaning* are really separable so that the existent mental state may be studied apart from its significance.

We have argued, on the contrary, that meaning and process (we prefer *object* to process) never separate *except* in the problematical situation. It is fallacious to take this exceptional situation as typical of all experience. Meaning is by no means always attended to. On the contrary it is usually so embodied or integrated with the object that it is not and cannot be separately considered. The test here is a purely empirical one; it is a question of fact, not of theory. The objects of our experience, in their ordinary presentation, we repeat, are to a considerable extent, "constituted by their relations." Every item of experience gets its character from the situation in which it appears. No object stands *completely* by itself, in absolute self-contained identity. But when an object does take on a *relatively* self-contained status—so that it seems peculiar or strange—then *it attracts our attention and becomes an object of thought.* We have repeated this statement in order to give it emphasis, for it is essential to an understanding of the interpretation of the thought process here set forth.

Thought at the Association Level.—So much for the conditions under which a thinking process is initiated, and set going.

When we attempt a closer analysis of our daily "trains of thought," whereby the meanings of problematical objects are developed, we are led first of all to distinguish between what may be called associative thought—and reasoning proper. We must first say something about thought of the associative level.

Those who follow the associationist tradition in psychology represent *all* thinking as trains of associated elements of consciousness. In the chapter on Memory we reviewed the "laws of association" as these have been formulated in times past. The thought of A leads to the thought of B, and B leads in turn to C, because at some former time in the individual's experience A and B, B and C, have been experienced together, and have thus become linked by associative bonds. Thus our associative thinking follows the lines of past experience and learning; is, in a sense, governed by *habit.*

Very often, as we attempt to develop the meaning of a problematical object, our thinking follows associative links in the manner indicated above. The object suggests this, or that, or some other fact that has been connected with it in past experience, or reminds us of something resembling it, so that, being led by association from A to B, and from B to C, and finally to D, we conclude that the puzzling object is a *kind of D* (or at least a relative of D), and is to be dealt with as such. What is the object yonder? It may be a pile of dirt, but its outlines are sharp, as if it were a solid material, and its color is not that of the soil hereabouts; it is probably an irregular shaped boulder half-buried in the ground. Thus one's thought is led, by familiar associative ties, from one possibility to another, until a satisfactory solution is found. No special hindrance is encountered, while the process remains associative. Past experience seems to reach out and gather the object to itself, assimilating it, by means of significant resemblances, to what is already known.

If dogs, and other animals think at all, it is probably at this level. It is certain that the animals do learn to associate objects together: that they come to expect B after the perception of A, the two having been frequently experienced together. There is evidence, also, to show that the higher animals attempt to grasp the meaning of a new object in terms of familiar associations. Who has not seen a dog or a cat engaged in taking observations of a strange object? This kind of thinking, however, is routine, and never creative. Even among men, when some object is "made out" in terms of its resemblances to things already known, there is *recognition,* rather than *cognition.* The thing is placed—its significance is determined—by reading off its meaning in terms of familiar characteristics.

Concepts in Associative Thought.—In the human sphere, however, the qualities and attributes by which we associate objects together and assimilate new objects to former experiences are often *abstract.* Size, shape, color, weight—are not things, but *properties* of things. Human associations are characteristically of this abstract type. We can, of course, associate things as wholes, and no doubt a great deal of such unanalytical thinking is to be discovered in our more primitive dealings with things. But, even so, wholes must be associated in terms of *some* common property, however crude and inarticulate. And it is certain that the every-day thought of the civilized adult is fairly analytical, based on consciously distinguished attributes. Thus we think of people as kindly, temperamental, stolid, quizzical—we characterize them by means of these general qualities or properties and "size up" new acquaintances under the same rubrics.

Human thought, then, even at its lowest levels, is permeated by conception. We apprehend the meanings of things in terms of relationships. Now the peculiarity of an attribute like "shape" is that it is *general;* it is possessed by many objects. We can moreover, classify things according to their shapes into many sub-groups. The general attribute becomes the ground upon which we think things together into systems. Without this capacity for abstraction we should never get very far in science. But, over and above this, *we can make shape itself an object of study.*

Psychologists have frequently maintained that our faculty of abstraction, whereby we isolate the properties of things, and make them specific objects of study, is to be explained on purely empirical grounds. The process of isolating a general quality may be represented in this fashion: given a series of experiences—

Axyqf
Bmnqc
Cdlqy
Desqm

—we run through them time and again until the general property which they possess in common, *q*, is shaken loose and thus *abstracted* or drawn out of its experiential setting. This, however, is only half the truth. For no such comparison as is implied could be carried out except on the basis of a previous analysis of the several wholes. The analytical movement, itself, must be *conceptual,* in order to reach the end described. Perception without conception is blind; conception without perception is empty. Or, to put the matter in other words, which we employed in the chapter on Attention, every synthetic movement of thought is accompanied by an analytical movement no less profound and primitive.

It is true, however, that human thought begins at the point where we learn to isolate, identify, and name the general properties of things. We make a business, very often, of studying the special traits and aspects of things with which we come into contact. This natural tendency is promoted by what we learn from others. We take over most of our concepts from the fund of such ideas possessed by our fellows. The abstract term "viscosity," for instance, is one that we can use correctly only after we have, by experience, become acquainted with the general property which it denotes.

By thus naming the general properties of things we make thought objective and *communicable*. Without such concepts we should be dumb, left at the *merely* perceputal, or stimulus-response level of thought. Our language, however, is an issue of thought itself. We must identify, before we can refer to. Hence language cannot be explained on a mere stimulus-response basis: it implies the deeper lying processes of discrimination and comparison of which we have spoken hitherto. No individual, in whom these fundamental processes are undeveloped, can ever rise to the level of thought at which language is used as an instrument.

The Conceptualizing Process.—The process by which we mark out and designate things and their properties is no other than the conscious process itself which, directed upon the characteristics of things, grasps them in their general nature and reference. There is a sense in which objects do not necessarily possess such properties as "size," "shape," and "weight." A savage, for instance, does not grasp these attributes in any such fashion as a specialist in physics. Objects, as they exist in the savage's experience, *have* no such features. It is the conscious process, through its analysis and discrimination, that leads us to apprehend the qualities of objects, and thus gives them status as real items in the experience of the individual.

If we began life, as children, confronted by a world composed of wholly distinct and separate entities, whose relationships were not given, but wholly to be discovered, the conceptualizing process could never get very far. But, in truth, these self-identical originals of our experience are wholly mythical. From the beginning our worlds are made up of *things related,* although at first the world lacks the differentiations which it is later to develop. What we do, by our successive conscious processes, is to mark out, within the total *continuum* of experience, now this object, now another, relating and placing as we go. Experience develops as an organized system from the beginning. And, as it grows, it develops differentiations concomitantly with increased relationships between the parts marked out. This is the principle of growth of all living things.

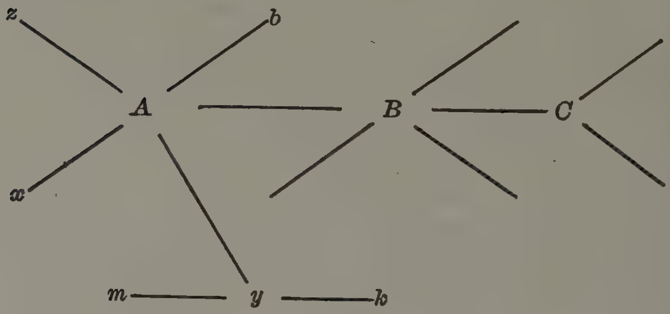
We must emphasize here a truth to which we have often referred in the course of our discussions: namely, that each and every movement of consciousness results in the creation of some new differentiation within experience. We attend to objects with the precise purpose of breaking down their isolation and discovering their relationships. This involves discrimination as well as comparison. Thus all that any individual possesses in the way of experience is a product of his own conscious activity. The world, *as it is for him,* is a growth, whose budding-point is his own conscious endeavor to grasp and understand the nature of things.

We are to observe here that any truly human experience is developed and differentiated in conceptual terms; it is an affair of abstract qualities and relationships. Even the lowest of individuals must learn to classify and deal with objects in terms of their common properties. We have said that the most primitive conceptions of objects are in terms of *use.* What is a knife? "It is to cut with," says the child or inferior adult. But a normal grown-up will answer, "It is a cutting-instrument, with a metal blade," or words of like import, referring the knife to a *class* of things. At a still higher stage of sophistication we develop the abstract concepts of science. Growth in knowledge is thus a process of organizing our worlds, perceiving, conceiving, understanding them in ever more subtle differentiations and relationships.

The Movement of Thought at the Associative Level.—When, therefore, we trace an associative connection between A and B, and B and C, we represent the facts but feebly if we assume that this association is external and incidental to the terms associated. A, B, and C, on the contrary, are just the facts that they are because of their relationships to other facts. We falsify, wherefore, if we represent an associative train in this fashion:

A——B——C

We must, on the contrary, if we use any kind of diagram, introduce a great complex of relational ties. The idea below represents the idea though very imperfectly:



Thus A is the thing that it is, because of its relationship to x, y, z, m, n, and a thousand other facts, and the same for B and C. These other facts, likewise, determine the course of any associative train of thought. In the end, *our trains of thought are directed by the whole organization of our system of experience, not by a few associative ties taken in isolation.* No thought-process, at any level, can be represented as a simple movement from fact to fact; every process, on the contrary, is determined by the state of stress and strain, of potential and resistance, existing within the total system of the moment. Thought, then, at the associative level, is no mere play of isolated ideas upon one another; it is a movement whose course is determined by the push and pull of the individual's total nature.

Abstract interpretations of the thought-process have never been found satisfactory. We must view thought, not as something apart from the "natural" processes of the body, the mysterious and self-contained activity of a "mind" set over against nature, but, rather, as the activity of the *concrete self,* the unified and organized individual. This note of warning is especially necessary where associationism is concerned because, as we have seen, it gives us an outline sketch of the thought-process which is in part valid, but it fails to show how the single train of thought is governed by the total nature of the individual. This criticism holds generally for all "systems" of psychology which treat of consciousness as a compound of elements.

How Reasoning Differs from Associative Thought.—Our ordinary associative trains of thought suffice for "making out" the nature of most objects with which we come into contact. Sometimes, however, a more subtle process is called into action, which we call *reasoning.* This, we have always been assured, is the distinctively human mode of thought and we shall discuss its distinctive traits.

At the associative level of thought, as we have seen, we move from A to B, and from B to C, in a kind of *two-term* series of steps. Reasoning might, on the other hand, be called a *three-term* process, since we move from A to B, not directly, but through a *middle term;* A—m—B. Consider, for a moment, the time-honored syllogism:

All men are Mortal
Socrates is a Man
Hence: Socrates is Mortal

Here we move from Socrates to mortality through the middle term, *man*. Socrates is mortal *because* he is a man.

Socrates—*Man*—Mortal

Thus we reach the conclusion that A and B are connected on the ground of certain *other facts* which imply such a relationship, although A and B may never have been heretofore experienced or even thought of as so related. It is the presence of these middle terms that characterizes true reasoning.

Now, in truth, middle terms can be found in associative thought, provided we search for them. This is indicated in the diagram above, where we have represented the movement from A to B as being directed or controlled by x, y, z, m, n, etc. In reasoning, however, the middle terms are made explicit; they are brought to light, and their implication are investigated. Reasoning thus appears as a kind of extension or development of our more ordinary thought processes.

Signs and Things Signified.—A human footprint in the sand is a *sign* that somebody has been here. The footprint means or points to a person. Now at the associative level of thought we may explain this reference quite simply by observing that footprints and human feet have been contiguously associated in times past, so that when the one is seen it tends to suggest the other. There is, in such a case, a kind of direct, two-term movement from A to B that is explicable in terms of habit. But let us take a more elaborate case of thinking. The classical case of the discovery of Neptune, as stated by Professor Creighton in *An Introductory Logic,* will serve. "In 1781 a new planet was discovered moving outside all the other planets by Sir William Herschel. This was the planet Uranus. When its orbit came to be calculated, it was found that it did not move as it might be expected to do according to the theory of gravitation. That is, the attraction of the sun and the known planets did not account for the path it took; it moved outwards into space farther than it ought to have done. It was evident that either some mistake must have been made in the observation of the astronomers, or some unknown body must be dragging it out of its course. No traces of any such planet could be perceived, and the problem remained unsolved. In 1843, a student at St. John's College, Cambridge, named Adams, undertook to work out the movements of Uranus, to discover, if possible, the position of the body which was pulling it out of what would otherwise be its proper path, the attractions exercised by the sun and the planets in their different positions, and to show what effect they would have in determining the orbit of Uranus. Whenever the planet was deflected outwards, it was necessary to show where the body was situated which was thus influencing it. In 1845 he was able to send a paper to the astronomer royal at Greenwich, informing him what quarter of the heavens the new planet should be observed. When the discovery was afterwards made, it was proved that his calculations are almost exactly correct. A failure on the part of the astronomer royal to coöperate by looking through his telescope for the planet gave the prior right of discovery to a Frenchman named Leverrier. The latter worked out his calculations in the same way as Adams and obtained almost exactly the same results. He sent these results to Professor Galle of the Berlin University on the 23rd September, 1846, asking him to look in the part of the heavens which he indicated. That evening, by following out the directions, the planet was discovered in almost the exact spot indicated."

Here A (the perturbation of Uranus) is causally connected with B (a new planet) through certain middle terms which mean, or "point to" the presence of such a body.

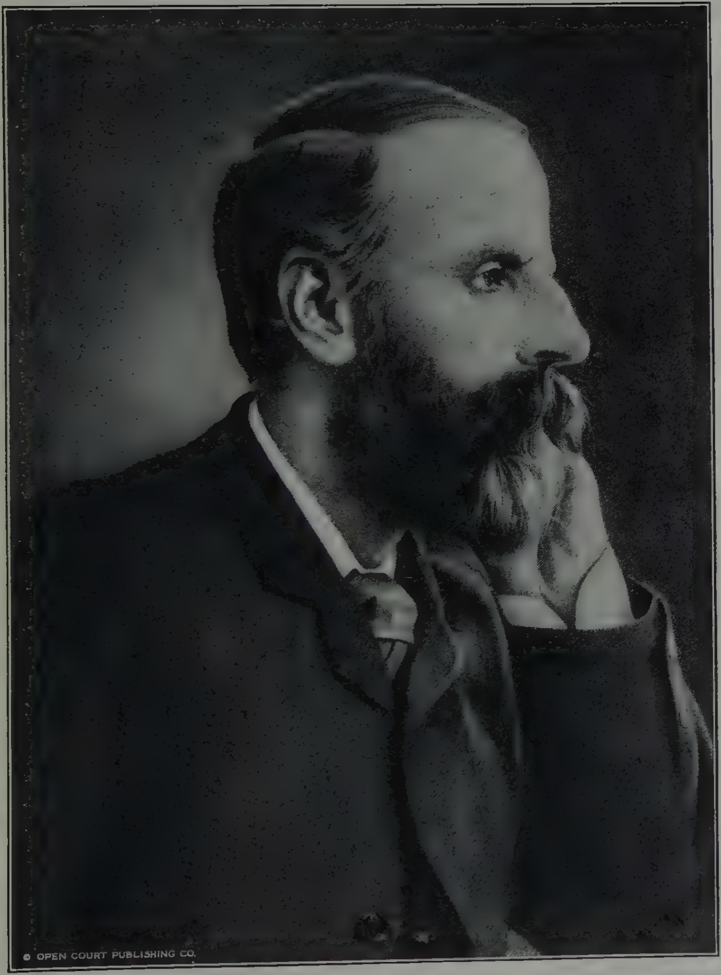
In this instance the middle terms may be said to be the degree and direction of the perturbation observed; they are characteristics of A. Now in what sense do they mean or point to B? They have never done so before, why now? We get our answer by observing that we are dealing here with an astronomical *system*, within which the members of the solar system are conceived to sustain definite and known relationships to one another. The whole Newtonian system, then, really pointed to a connection between Uranus and the unknown body, when once the extent and nature of the perturbation was known.

Now in a similar manner we trace, in all reasoning, a connection between A and B against the background of some kind of a system of facts. It is because the two facts are thought of as elements related *through* the medium of such a system that we can trace a connection between them.

Steps in the Reasoning Process.—Any true process of reasoning, we have observed, involves the tracing out of the implications of middle terms, where these had never before been followed to the same conclusion. The first business of the reasoner, therefore is *the discovery of middle terms.*

This is done by analysis and abstraction. The total unanalyzed fact A, which sets our problem, tells us, in itself, nothing. We must break it up. We must consider it in all of its aspects quite thoroughly. Whose handkerchief is this? It is impossible to tell, without examination. We pick it up, note its various traits, consider their implications. Finally we fix upon the *perfume* which it carries, and are led to conclude that it must belong to sister Anne, because she affects that particular brand of the stuff. The unanalyzed fact yields no results. We get to B through the *odor*, which is our middle term. By fixing attention upon the perfume, and considering *its* associates, we were led to connect the object with Anne.

Analysis, then, is the first step in a reasoning process.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(*See p.* 458)

Analysis may be an extremely simple affair, of the type just indicated, or it may be exceedingly complex. An analysis may occupy a moment, or it may take years. But its general purport is always the same. It is preliminary to the selection of a middle term. Aside from this as an end, analysis is meaningless.

The second step in reasoning, then, is the selection of a middle term. Having analyzed, we then fix upon a certain factor presented by our analysis as the *nub* of the matter. This selection, to be sure, is not a wholly distinct process, separate from analysis. But when the middle term has been hit upon our reasoning passes into a new stage.

In the third place, we follow out the implications of our middle terms to some kind of conclusion. This hole in the wall, we discover by analysis (very brief here, to be sure) is circular and jagged in outline. Now *this* condition of the glass must have resulted from—and we pass into the stage of following out the implications of the extracted middle term. Such a process of inference, which depends upon tracing out the various possible meanings of the middle term, may, again, be either brief or long continued. In the case of the discovery of Neptune, for instance, it was a long calculation.

Finally, having reached a conclusion, the conclusion must usually be *verified*. The validity of the connection traced must be established. This, of course, is because three-term thinking is always somewhat uncertain and tentative. Scientific method, accordingly, lays great stress upon the testing and proofs of conclusion reached by reasoning.

Analysis and Description.—Given a problem, then, our first step is an analysis of the problematical object. In our chapter on Attention we observed that any attentive (or conscious) process involves such analysis. This analysis, however, may be at the *perceptual* level—a matter of looking, listening, or touching—or it may be a matter of the most complicated conceptual examination. There is a distinct limit to what we may accomplish in the way of direct sensory observation. In our more advanced process of thought we call *schemes* and *devices* into play to assist our observation. We diagram, measure, employ instruments, use statistical methods. The process of analysis becomes a *program.* We make analysis a business, and prescribe, so far as possible, its methods.

Thus in the sciences analysis becomes a highly complicated procedure. Chemistry, for instance, cannot get very far without analysis, and chemical analysis is almost a science in itself. Psychological analysis, as practiced by the introspectionists, has developed a highly elaborate technique. But, in the end, analysis aims at making clear what is ''there'' in the problematical object; it hopes to reveal the many aspects, qualities, attributes, properties of the thing, in a form as definite as possible.

In the course of an analysis *concepts come to be used as instruments.* Consider, for instance, the quantitative concepts, and how extensively they are employed. We measure, in mathematical terms, the shapes, sizes, weights and densities of bodies, all of them conceived in terms of standard units. These concepts are highly stabilized. An inch or a meter, a quart or a circle, represent fixed and definite meanings, or orders of relationship. Units and standards are the soul of scientific analysis. Sometimes we forget their conceptual character. A centimeter is nothing *absolute,* after all, as Einstein has recently reminded us, but a *comparative* term. The units and standards are *ideas,* not things.

Every science has its own instrumental concepts, which serve as tools of analysis, so that these differ widely in various fields. Thus psycho-analysis, with its libido, its suppression, sublimation, and substitution, has developed a whole set of instrumental concepts of the most abstract type. These notions are, indeed, instruments of analysis. They represent no concrete realities but, so far as they represent anything objective, relations-between-ideas. Compare such a set of ideas with those used by the business "expert" who diagnoses a failing business. This expert also deals in relationships, ratios, and expresses his comparisons in conceptual terms. These concepts are the regular tools of his business. Analysis would be impossible without them.

Description is closely allied to analysis; it consists in the *recording* of the facts brought to light by analysis. Description requires the use of symbols, standardized signs. These vary from science to science, and from one field of observation to another. Standardized description is, indeed, one of the most conspicuous features of scientific procedure. One of the great aims of science is to record its findings in such terms that the original observation may be repeated by other experimenters. This uniformity, to be sure, goes back to analysis itself, so far as standardized concepts and methods are employed. But in analysis individual initiative is possible and desirable; one must use one's "gumption." Individual ways of doing things, however, have no place in description, which must set forth, in universal terms, conclusions which, it is hoped, may be verified by general agreement. Hence scientific description is rigid and rigorous

Ingenuity and Analysis.—Analysis, then, employs, in its sophisticated form, standardized concepts as instruments in its operations. There are, nevertheless, great differences between people in analytical ability. Some men seem to "see through" a situation at a glance; others remain bewildered in the presence of its complexity. Now, in the first place, there can be no question that an individual's ability to analyze a situation depends, in the first place, upon his previous experience and learning. This is so obvious as to call for no comment. But when the experience-factors are equalized there still remain differences between individuals—in respect to their analytical ability—which are grounded in something more profound than mere learning. Some people, more than others, seem to be endowed by nature with a greater fluidity of thought, a greater resource in the way of expedients. While scientific analysis, therefore, is often highly methodical, up to a certain point, it is no mere matter of following fixed methods to a conclusion. And learning, by itself, will never produce a great thinker.

In what does this ingenuity, with which some individuals are endowed, consist? It seems to be resolvable into a certain alertness or flexibility of mind. The successful scientist shows a superior energy in his pursuit of possible solutions; his survey of a situation is more dynamic, intense, resolute. This, however, would not avail, were not his associative processes unusually plastic and spontaneous. We come here upon something allied to the fanciful play of imagination of which we spoke in a previous chapter. Here remote connections are observed or invented; analogies are pushed to extremes. Routine is of no avail here; habit is left behind. It is in such situations that thought reaches the extreme of initiative and plasticity, and appears less mechanical than in other relations.

The Selection of Middle Terms.— A reasoning process passes into its second stage when the essential feature of a situation is once hit upon. When, for instance, after analysis, the mosquito is found to be the carrier of malarial germs, the first stage of the reasoning process is concluded, and we pass on to new conquests.

But this extraction of the middle term, or essence of a situation, is more complicated than our statement might seem to imply. It involves, moreover, something over and above mere analysis and description. For analysis, as such, merely tells us *what* is there; analysis, in itself, shows no preferences. It may uncover a thousand interesting facts, but which of them is the key to the problem? In the end, it is simple enough to record the fact that the tsetse-fly is the carrier of sleeping sickness. But how did it come about that *this* insect was accused of causing the trouble, when there are so many insects, and so many other ways in which infection might be spread?

Mere guesses, in such a situation, would hardly serve. We must consider the facts which analysis brings to light in their bearing upon the general problem in hand. We must know the customs of the tsetse-fly, the range of its habitat, and the conditions under which it carries on its murderous work. We must have carried our studies to the point where we know that *this* fly is the one possible and real cause of the condition which confronts us. This, at least, when our thinking is at the causal level of explanation.

John Stuart Mill has given us, in his inductive logic, a very well formulated account of the methods by which we proceed to isolate our middle terms and thus to pass from them to a conclusion. Thus the tsetse-fly is said to be the cause of sleeping-sickness if it can be shown that it is present (and biting) in all areas of illness; that it is *not* present in cases where the disease does not develop; that the prevalence of the disease varies concomitantly with the prevalence of the fly, and so on. But all of these applications of the methods of difference, agreement, concomitant variations, and the like, involve long programs of study, in most cases. The discovery of the middle terms does *not* follow, as so many empiricists would seem to suppose, from the mere examination of the detailed facts. The essence, or middle term, does not stand up and proclaim itself; it must be sought with energy and persistence.

In the course of the ordinary reasoning process, where the analytical process is flexible and not too complicated, we may frequently fix upon some salient characteristic of our object, which has been isolated by analysis, and consider whether it may not be the middle term which we seek. The automobile engine is missing fire. We analyze. It occurs to us that the distributor may not be functioning perfectly. So we proceed for a moment *on the hypothesis* that the distributor is misbehaving. If this seems plausible, after consideration, in the light of such facts as we possess, we may be led to give the hypothesis a thorough trial.

Ideal Experiment.—It is, indeed, in connection with the discovery of middle terms that we find *ideal experiment* most typical and frequent. Hypothesis, too, is a feature of ideal experimentation. We may very often, of course, test an hypothesis by *actual* experiment; by trying, for instance, to readjust the distributor. More frequently actual experimentation is either not possible or too costly in time and effort. We must come to a decision of some kind in advance of our actual test of the hypothesis. It is then that our selection of middle terms becomes most careful and calculating. In this process "level-headedness" rather ingenuity, is at a premium. Here good judgent reveals itself in the reaching of valid conclusions. Judgment is here partly a matter of how much the individual *knows* about the vital factors in such a situation, partly a matter of sanity, of poise and balance, in the use of such knowledge.

It is necessary that the investigator, in considering the possibilities before him, exclude, in the first place, those factors which are not likely to be of consequence, and fix upon the elements which are most likely to give him the key to his problem. This, of course, is largely a matter of general knowledge, as it would be in making a medical diagnosis. In the further task of testing out the possibilities of several candidates for the position of middle term, ideal experiment comes conspicuously into play. Candidate A must be considered, for instance, in all its bearings and implications. Fact must be weighed against fact, possibility against possibility—and a final judgment must be rendered on the evidence thus reviewed. It is a rare mind, indeed, that is able to continue such a process of mental experimentation to any length, without exhaustion. We are likely to grow impatient, to hurry the process, to incline toward the immediately attractive hypothesis, or the one most pleasing. We are likely to be prejudiced in favor of this or that bit of evidence, and driven by our impatience towards the conclusion that our secret heart desires. Such tendencies, of course, are deadly enemies of good judgment.

Our reasoning, we are accustomed to say, should be objective and impersonal. We must away with all bias if we would reason soundly. But probably this means no more than that our *ideal* experimentation should follow the lines of an actual testing. It is a matter of thorough experimentation, of careful construction employing the actual facts involved. The process must not be interrupted, stunted, or shunted off its proper path, but must go forward naturally to its termination.

The Third Step in Reasoning.—When, however, our middle term is once isolated and fixed upon, the reasoning process still remains incomplete. When the man who has made an analysis of his business has fixed upon the delivery system as the cause of his failures, he has still the question, What can be done about it? or, the mechanic who has decided that the carburetor of his engine is out of order, has still the task of adjusting the difficulty. Reasoning, we said, begins with a *problem,* and it ends when the problem is solved. After the selection of the middle term reasoning enters upon a distinctly new stage; but it does not, nevertheless, become a *new* reasoning process. For the solution of the difficulty will be largely guided by what has already come to light; it will not be indifferent to what has preceded, but will be on the contrary an extension of the same general process of inquiry.

Our scientific processes are often so intricate, to be sure, that they seem scarcely to follow the steps of the reasoning process which we have outlined. Sometimes a scientific program is one of analysis pure and simple; sometimes it ends when a cause has been isolated or determined, or a universal connection discovered. But such programs, from the standpoint of the whole science, are found to be partial. It is something, for instance, to have isolated a new chemical element, or a new fever germ. But such feats are only the beginnings of processes of inquiry which have endless ramifications. The total process of reasoning is as we have described it, when its whole sweep is considered.

Our casting about for ways and means towards the solution of a problem may very well involve, like the selection of the middle term, ideal experimentation. It is always something more than a mere "trial and error" process. Thus a man seeking to improve his delivery system, in order to save his business, does not try anything or everything at random. On the contrary, he reviews the methods which might be used with reference to his peculiar difficulties, as disclosed by his previous analysis. He constructs, in imagination, a total situation, to which he refers the proposed methods, and mentally views them in operation. This kind of calculation, to be sure, may be aided by statistics, by inquiries, by tentative actual experiments.

Proof.—And finally, having selected a method of solving the problem, the thinker must be prepared to put it to the test. This suggests that any conclusion reached by reasoning is quite subject to error; and this is quite generally true, except in such purely deductive exercises as mathematics. Reasoning seldom, in itself, returns dead-sure conclusions, but is always tentative and provisional.

How may we be sure that our tentative solution is the correct one? We may, in the first place, *put it to work.* The truth of any proposition, as the pragmatists tell us, is to be demonstrated by its ability to lead us to satisfactory results. We can only be certain that this antitoxin after we have proved, by a number of trials, that it works as predicted. The Copernican theory is valid so long as, by using it, our calculations on the solar system continue to be successful.

The process of testing may involve a great deal of figuring and tabulating, of checking and comparing. It is not always easy to discover just how a process or an idea *does* work. The value of a graduated income tax, for instance, may be a matter of considerable dispute: the same is true for the relativity theory in modern physics. Proof, then, is in many cases a highly elaborate procedure. But its fundamentals remain, in all cases, relatively simple.

We have made no mention so far of the principle of consistency, or non-contradiction, on which so many of the logicians dwell in their studies of the reasoning process. According to this principle a theory is true when it accords with the facts of experience in such fashion as to be valid in all the relationships to which it pertains; to be contradicted by none. The principle is sound, in so far as it takes account of the fact that experience is an organized affair, and that any new truth must conform or be made to conform to the body of knowledge already possessed. A man *might* lift himself by his own boot-straps, or a perpetual motion machine *might* be invented but in some other world than this of ours. Such events would contradict all that we know, our whole system of physics and astronomy. We rule out such theories as are not consistent with the organized system of our knowledge. The logical statement, however, does not do full justice to the principle of consistency.

From the standpoint of the individual thinker, experience *must* be consistent, if thinking is ever to get ahead. This is the very essence of sanity. To test a conclusion, then, is to prove its conformity with our present assured knowledge, no less than to ascertain its "workings" in actual practice. Where our testing is largely a matter of *thinking out* the consequences of a theory, the principle of consistency is of the highest moment.

Reasoning a Program of Study.—Such then, are the stages through which the complete reasoning process will pass. In many cases, as we have said, the process will not be carried out in full because, for instance, analysis may not be required, or the middle term may be immediately given, or the conclusion may follow immediately in the light of established precedent. The typical, complete act of reasoning, therefore, is not often carried through from end to end.

We must remember, above all, that a reasoning process is reflective or deliberate; it is a self-conscious procedure. In the civilized sphere of life, at least, reasoning is not a native process, but a highly developed and schematic affair, governed by rules and precedents. Reasoning is a kind of continuous program in the course of which many simple conscious processes are employed.

Underlying this sophisticated program, which is designed to utilize our conceptional powers to the highest advantage, is the flow of consciousness upon which it is supported. Our higher conscious processes, in these their higher manifestations, have never been subjected to careful psychological study. This may be because we have labored under the belief that we were bound to begin our studies with the lower and simpler processes and work upward from them to the higher. As we have seen, however, conception is an indispensable factor in any thinking that may be called human; conceptual thought permeates all our conscious behavior.

CHAPTER XI

FEELING AND EMOTION

> "How singular is the thing called pleasure and how curiously related to pain, which might be thought to be the opposite of it; for they are never present to a man at the same instant, and yet he who pursues either is generally compelled to take the other; their bodies are two, but they are joined by a single head."—PLATO

The pleasantness that suffuses the organism when one is satisfied and at rest is a *feeling*. In such a circumstance there is no contemplation of the situation that surrounds one. It might be impossible for one to give a reason for one's pleasurable experience, however insistent the questioner. Indeed it is always impossible to afford a reason for feeling until one has looked upon it retrospectively in an attempt to describe the circumstances that in some way seem to have occasioned it.

Unpleasantness, too, is a feeling. It is opposite in quality to pleasantness and implies no act of reflection upon the conditions that are associated with it.

Remote from the immediate experience of most of us are those states of euphoria and of depression which we observe in great numbers of persons who are suffering from mental disturbance. They are pleasantly or unpleasantly affected and at the same time are totally unable to assert any reason for their state of affairs. In fact, the feeling may be opposite to what the surrounding circumstances would normally be expected to occasion. The euphoric, for example, may be set about by the most untoward conditions imaginable: poverty, filth, barred doors and windows, restraining officers and what not; he may be aware of all these evidences that he is not his own master; he may acknowledge their character when his attention is drawn to them, and yet he may be in a state of pleasantness just *because he is so.* The converse is often apparent in the melancholiac or in the patient who is on the verge of melancholia.

All this suggests the meaning of the phrase: "Feelings are not cognitive." That is, they are not states of knowing the conditions that have occasioned them or even of reflecting about them. They defy analysis. They are simple states, and are of two opposed qualities: pleasantness and unpleasantness. Excitement and repose have sometimes been advanced as terms descriptive of other distinct feelings. But by the consensus of present opinion they are, fundamentally, only pleasantness and unpleasantness with the addition of some consciousness of the situation. Because of their unanalyzable character, feelings have sometimes been called mental elements, correlative with sensation.

In the foregoing we have tried to make clear what the student of psychology means by the term "feeling." By contrast, the word, in popular speech, is often used idiomatically. For example, we say: "I *feel* cold." In this case we refer to a sensation. Or we say: "I *feel* that the argument is sound" when we mean, of course: "I *think* the argument is sound." Once more we say: "I *feel* angry" when we are describing a state of emotion.

Distinguished from Sensation.—There is one important difference between feeling and sensation that is suggestive of a theory of feeling. Sensation is always localized in a particular portion of the organism; as in a sense organ. That is, it seems to belong to a sense organ; or (in the case of pain perhaps) to some other bodily structures. This notion, of course, is always given to us by introspection. When, for instance, we experience a sense of color or of brightness (when we "have a *sensation*" of red, e.g., or of white) it always seems to us that the eye is performing one of its functions: that the sensation is *localized* in the organ of vision; similarly as to the ear in the case of auditory sensation and so on through the list of our sensory departments. It is not so with our feelings of pleasantness and of unpleasantness. These experiences appear to belong to no particular organ. Rather they seem to be the property of the organism as a whole. The feeling is through and through us, and we are *entirely* pleasant or unpleasant. It may be for this reason that we can introspectively turn and examine a sensation while we cannot do so in the case of a feeling. The moment we attempt it, it vanishes, and we are left quite cold and indifferent. The most we can do is to turn back mentally to examine the conditions in which we, a moment earlier, were pleasantly or unpleasantly disposed; or to set about a description of those conditions and to reflect upon them for the purpose of determining whether they are causally or otherwise associated with the feeling.

Theory of Feeling.—The foregoing observations suggest an *organic* theory of feeling. Feelings, according to this theory, arise with those organic processes that run along with our impulsions. We mean those impulsions that many identify with the instincts; and not only these, but all others that arise from our habit sets and the like. And they run along with all other behavior processes that fill up our daily work. All these processes are conceived according to the organic theory, as occasions of the feelings of pleasantness and unpleasantness.

But feelings occur in association with thinking, imagining, recalling, and in fact with any mental process whatever. For sensation has its "feeling tone" and so have perceiving, thinking, recalling, and all the rest. It is not, then, with overt muscular contractions and relaxations; with organic processes of digestion, breathing and the like, in *themselves alone,* that feelings are associated causally or otherwise. It is with reactions *in toto,* that they are tied up and these reactions very often include thinking, imagining, and other forms of activity of consciousness. Unless this observation is kept in mind, the feelings of pleasantness and of unpleasantness may wrongly be confused with organic and muscular sensations and with pain.

The close alliance between feeling and sensation that often amounts to an identification of the two leads directly to the camp of other theorists who urge that feeling is not distinct from sensation, but that it is an aspect of it; and that it is an *aspect* of other forms of conscious life also and not separable from them. Now if feeling is only an aspect of sensation and the like, it ought never to be lacking during conscious activity. But it is very often entirely wanting. Many of our sensory and other experiences are wholly indifferent as far as feeling is concerned. Our perception of a symmetrical tree in the meadow, for example, at first fills us with pleasurable feeling. But familiarity with the scene breeds indifference and we are ultimately quite unaffected by it. Sensation and perception are there, but feeling is lacking. The most thrilling imaginings, after a season, lose their color. The sophisticated and over-stimulated city resident becomes blasé.

These observations will find confirmation in the experience of every reader and they may be interpreted as coinciding with the organic theory of feeling. We are dealing here, most probably, with a short-circuiting of organic processes that normally are in the circuit. Having been "shorted," their correlates, the feelings, drop out of view. What we are discussing here is quite analogous to what goes on in every process of learning a new motor adjustment. When we are acquiring the habits, for example, that are essential to riding a bicycle or playing tennis, we drop out one unessential part reaction after another, such as contorting the body and holding the breath, until at last only the bare essentials are left and then we ride and play gracefully and at our ease. Many physiological part-adjustments have been short-circuited in the course of learning. It must not be forgotten that the phrases "habit formation" and "learning" apply not only to coarse external adjustments but to fine internal or implicit ones as well.

A third theory is based upon an assumed relative resistance to action: resistance in the nervous elements. When this is great, there is unpleasantness; when it has been removed there is pleasantness associated with action. The obstruction conceived of in this case, in the last analysis, impedes the flow of nervous energy across the synapses. The theory sounds plausible enough. But the difficulty is that a reaction that is unpleasant, for any reason, loses its feeling quality altogether after a season of practice and habituation when the exercise has become purely routine and the resistance to the flow of nervous energy has been obliterated. This observation may be made with equal force in relation to a reaction that was primarily pleasant. Observe, for example, the thrill of pleasurable feeling one experiences when, as a novice, one realizes that one is gaining control of a high-powered car driven in the streets. After a season the whole thing is taken as a matter of course, and the feeling element has disappeared from experience. This sloughing off of feeling, stands in the way, therefore, of regarding it as an *aspect* of sensation, perception and the like, which we have pointed out earlier, and also of the theory that feelings are occasioned by greater or less resistance to the flow of nervous energy.

A fourth theory brings us near again to what we were saying in connection with the organic theory. Feeling is impulsive. It is our *impulse* to escape from certain sensations and to approach or to hold on to others. In the one case we are pleasantly disposed and in the other unpleasantly. We by impulse seek to be rid of cold and it is unpleasant. In the same way we seek warmth and it is pleasant. Those situations that are indifferent we do not seek to approach or to avoid, or to retain. This is the simplest and most satisfactory theory of feeling. But the "certain situations" that we seek to attain to or to avoid may be very remote objects of conception only. So that one may be pleasantly disposed whilst rushing a blazing battery in battle or whilst bending during countless hours over a tedious microscope. Some agreeable prevision of advantages to be had when the battery shall have ceased firing, or when a contribution to the science of histology shall have been made, it may be, overwhelms the more immediate disagreeableness of the situation.

How Feelings are Aroused.—Certain sensory stimuli almost invariably arouse feelings of pleasantness and others are as often associated with unpleasantness. Sweet is always pleasant to taste—excepting in cases in which the organism has already been surfeited with sugar, in which case it is unpleasant. Even the idea or anticipation of a sweet taste is pleasant, with the above-mentioned exception. On the other hand, bitter is accompanied by the feeling of unpleasantness, excepting in case of certain minimal excitations and in certain compounds. Most people are pleasantly aroused by the slight bitter stimulus that is afforded by lemonade and orange-rind, spinach and olives. Any very intense stimulus arouses unpleasantness and the reaction of avoidance until success has been attained when pleasantness takes its place. The foregoing makes it apparent that when feelings are occasioned by sensory stimulation or by anticipation of it, the quality of feeling will depend upon the condition or preparation of the organism as a whole. We draw attention to something similar to this in our discussion of instinct. The hen will sit upon eggs, not when the stimulus is presented; *but* when the stimulus appears the hen must be "broody" else the act of sitting will not occur. If we were to speak of the hen's feeling reactions undoubtedly we should say that the stimulus leaves her in a state of indifference unless her organism is keyed up to sitting, whereas in the other case we may assume she is suffused with pleasure.

All feelings that are aroused merely by what we have hitherto called "adequate stimulation" of a sense organ, or excited by the occurrence of those impulsions that are often identified with instinct we call "primary feelings." Feelings in other cases are called "secondary." But they also always follow upon sensory stimulation, anticipation, retrospection and other mental states and processes.

Illustrations of the secondary feelings and the conditions of their excitation may now be given. A young man realizes that he is meeting with success in the study of medicine, and he is pleasurably excited. His own sense of growing mastery of his subject and signs of approval from his instructors are the stimuli. What corresponds to the organic preparation of which we have been speaking is his ambition to become a physician. This is an acquired "set" of emotionally colored ideals: acquired, that is, through learning and through social contacts and reactions. In the case of primary feelings the preparation is native (instinct) or it is a pathological state, or one occasioned by lack of food and drink, or by satiety, or it is a toxic condition. In any case the preparation is primarily biological. In the case of secondary feelings on the other hand, the preparation may be biological, to be sure, but it is a product of learning, or of social contacts. On the side of conciousness it is represented in ambition to succeed in a profession, e.g., or in vigorous purpose.

Furthermore, the primary feelings are reactions of pleasure or of unpleasure because of the objects themselves. It is for no ulterior purpose that we have pleasure in warmth or in sweet: it is for the thing itself. But we have to acquire a liking for many things such as green olives and tobacco. The pleasure we derive from these objects was not in the first instance in the objects themselves; it was social; and only after more or less long practice has it been aroused immediately by the act of eating the olive or smoking the tobacco. Illustrations of what we have in mind abound in the fine arts. High lights and brilliant colors arouse the feeling of pleasure primarily. It is only secondarily after a certain amount of training in artistic appreciation, that subdued lights and colors do likewise.

Instinct and Feelings.—We come now to the question of the rôle of instinct in relation to feelings. It has already been distinctly implied that those objects that satisfy instinct are directly pleasurable; and the instinct psychologists will urge with great plausibility that all other objects than these only secondarily arouse pleasure or unpleasure. The expert mathematician, for example, is one who, in common with all others, has an instinct of curiosity. If this instinct has been aroused by numbers, he begins to manipulate them; he finds problems there that he can solve and by solving them win social approval. And this in itself, says he, affords pleasure. His becoming an expert mathematician is a by-product, one might say, of his instinct of curiosity. Mathematical situations make no direct appeal to him. But on the other hand such a mathematician himself would undoubtedly reply that a situation involving number always did and does now appeal to him directly as beautiful, it may be, or at any rate as worth while for its own sake. From his own introspective viewpoint his nature cried out for mathematics quite as truly as for food. The pleasure derived therefrom was primary for this reason, precisely as in the case of pleasure that a hungry man experiences after having partaken of food.

Whether some feelings are primary and others secondary, or whether all are primary, is impossible of decision. And however that may be, the fact is that they arise in association with both native and acquired reactions.

Emotion.—Emotion is a term applied to such states of excitement as fear, anger, grief, joy, sorrow, amusement and disgust. They bear a certain resemblance to the feelings that we have been discussing in the preceding pages. Indeed, it may be said that on the side of consciousness the feeling of pleasantness or of unpleasantness is at the core of emotion: that the former is an attribute of the latter. Take away the feeling of pleasantness from joy and we would cease to be joyful. Remove unpleasantness from grief and we should no longer be grief-stricken.

There are certain resemblances between the two states also in respect to their mode of expression. The unmistakable bodily attitude in emotion may be described as exaggerations of the corresponding attitudes in unpleasantness and in pleasantness. The same may be said of facial expression and even of the quality of the voice, as well. The figures below illustrate expressions of mouth and eyes that are characteristic of various feelings and emotions.

Furthermore, the internal reactions in feeling and emotion respectively bear certain marks of resemblance, so far as these reactions are known. In each state there are alterations in heart and respiratory action, at least, as compared with what goes on in a state of indifference.

We drew attention above to the fact that feeling is unlike sensation in that it is definitely not localized in any sense organ or other part of the body. This may be said, too, of emotion, with perhaps a slight and unimportant qualification: several emotional states appear to be centralized

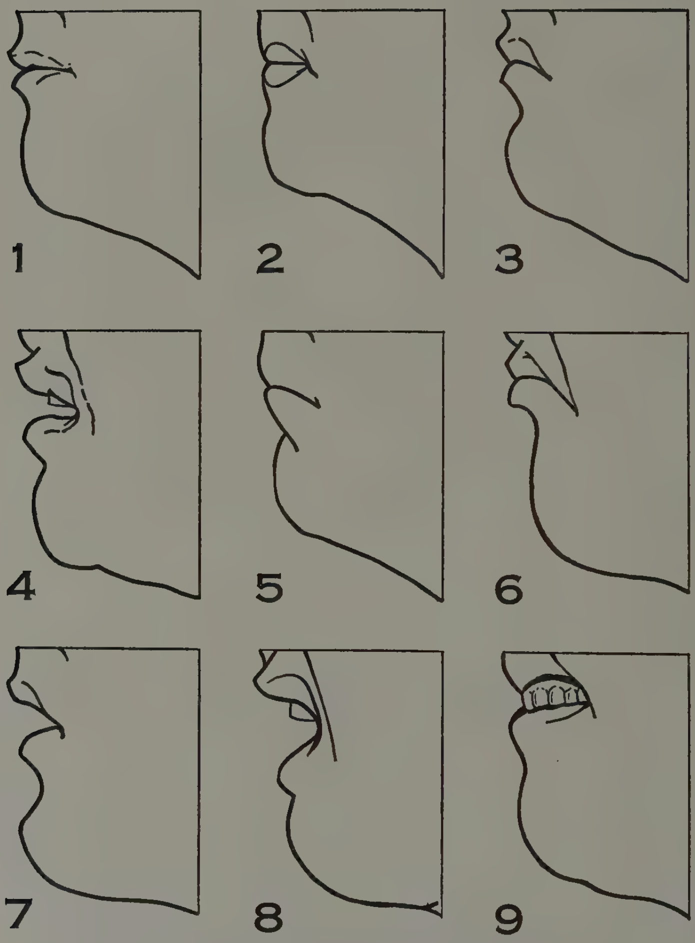

FIG. 39.—Emotions expressed by the mouth.

(From *American Journal of Psychology*, by permission of the editor.)

The mouth, according to Wundt, is fundamental in the expression of the emotions, because taste qualities, like sweet and bitter, are naturally correlated with pleasantness and unpleasantness and hence with acceptance and rejection, and are further correlated physiologically with regions of the tongue, which is most sensitive to sweet at the tip and to bitter at the root.

The figures above are from the *American Journal of Psychology*, Vol. 34, 475 ff., after Th. Piderit (*Mimik und Physiognomik*, 1867, 1886, 1909; reprinted in 1919). They are referred to as 1, 2, etc.

1. Normal mouth = passivity.

2. Sweet mouth = pleasantness. The lips are pressed together and drawn in and the tongue is pressed forward, so as to keep the sweet substance in the mouth and get the greatest effect from it. This is the basis of the pleasant expressions.

3. Bitter mouth = unpleasantness. The root of the tongue, most sensitive to bitter, is drawn down to avoid stimulation by the bitter substance, thus changing the contour of the neck. The lips are thrust out in incipient spewing (the pout). This is the basis of the unpleasant expressions.

4. Extremely bitter mouth = great unpleasantness; an exaggeration of 3. The tongue is drawn farther down; the lips are most protruded and the mouth is somewhat open; an extreme attitude of rejection.

5. Set mouth = stubbornness. The biological explanation is probably in Darwin's third principle: the spread of nervous energy. Lips are protruded and pressed tightly together, not opened as in 4; the corners are drawn down. The expression fundamentally means determination, but rejection also. Thus it is correlated with stubbornness.

6. Bitter and set mouth = unpleasant stubbornness. This expression is a combination of 4 and 5.

7. Open mouth = attention. The biological explanation is probably in facility for better breathing, not in alimentary readiness. The outline here is an alteration of that found in Piderit. Attention is not well revealed in the mouth alone. It requires the coöperation of the eyes and brows.

8. Bitter and open mouth = unpleasant attention; a combination of 4 and 7. It is a part of the expression of horror.

9. Clenched teeth = rage. The mouth is meant to show the bared canines of the snarl or sneer. It occurs in anger but always in coöperation with other facial expressions.

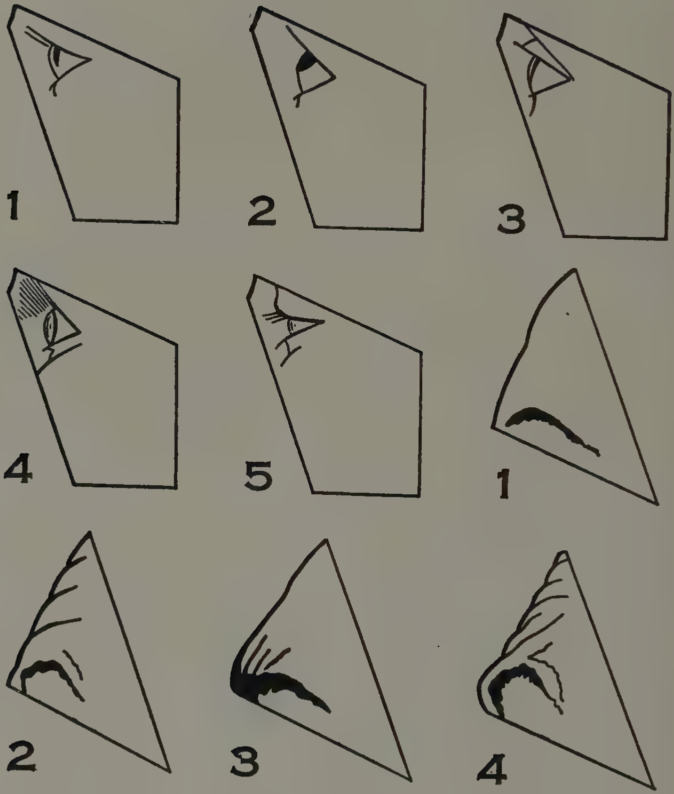

FIG. 40.—Eyes and brows in emotional expression.

The eyes and brows are in close coöperation in emotional expression. They are referred to as E 1 and B 1, etc.

E 1. Normal eye = passivity.

E 2. Raised eye = exaltation. The expression is symbolic and as such is distinctly human. It tends to imply "introversion," since reality is generally conceived as upon the ground.

E 3. Wide open eye = attention. Human attention is primarily visual. Ordinarily the brow is raised too (B 2). This expression is fundamental to the meaning of "extraversion."

E 4. Very wide open eye = great attention. More extreme than E 3 and always combined with the raised brow, B 2 or B 4. Properly it belongs only to the brow that is both raised and contracted (B 4), since it is the contraction of the brow that produces the shading above the eye, copied from Piderit's original drawing of horror.

E 5. Lowered lid = inattention. This expression is basal to "introversion" or to voluntary inattention. It can be referred to Darwin's principle of antithesis. (E 5 is the opposite of E 3), or to some more fundamental biological principle, allied to the conditioned reflex, which explains why some animals like the ostrich, it is said, refuse to look facts in the face. Most facts that have to be met are predominantly visual, and are thus partly removable by obstructing the visual perception.

1. Normal brow = passivity.

2. Raised brow (horizontal furrows) = attention. The expression belongs naturally to the wide open eye (E 3), but may give the meaning of attention apart from the eye.

3. Contracted brow (vertical furrows) = unpleasantness and thought. The assignment of two such apparently different meanings to the same expression seems odd at first, but active thought asociated with the contracted brow is usually supposed to be unpleasant. The common term on the side of meaning seems to be "introversion." The unpleasant is avoided; thought is subjective. In both the reality of visual perception is avoided (cf. E 5).

4. Raised and contracted brow (horizontal and vertical furrows) = unpleasant attention. There is nothing incompatible in the meaning of 2 and 3 to prevent their combination, except that, since the raised brow means attention ("extraversion"), the contracted brow with it can not mean thought ("introversion") and must mean unpleasantness. There is here, nevertheless, a genuine conflict positively expressed. The organism meets an unpleasant situation either by attending to it (raised brow) or by withdrawing from it (contracted brow), and the two contrary tendencies are simultaneously registered, as, for example, in horror when the organism tends to withdraw and yet is compelled to attend.

in the chest and others in the abdomen. It is this, no doubt, that led the ancients to speak of anger and of courage as belonging to the heart and of grief as located in the abdomen.

We have pointed out that feelings are not cognitive: that feeling is not a state of knowing about anything. This is not true of emotion. We are always angry *at* some thing or some person; we are always in grief *because* of some situation that is recognized, and we are always in love with some object that is vivid before us in imagination or otherwise. Once more, these states are unlike in that feeling is a relatively quiet condition. At most it is one of mild but steady tension while it lasts. Emotion, on the other hand, is tumultuous. There is great tension and sudden, spasmodic explosion of nervous energy.

Bodily Accompaniments of Emotion.—This brings us to describe certain bodily accompaniments of emotion to which already incidental reference has been made.

There is no mistaking the external muscular activity in certain emotional states such as joy and resentment and fear. Equally clear and characteristic is the facial expression in anger and in fear.

But our emotions are betrayed not only in the activation of our facial muscles. There are characteristic bodily postures as well. In anger we are drawn up to a formidable attitude; our chests are thrown out and our muscles bulge prominently. In fear we crouch and so lose our formidable appearance.

Of greater moment in this connection, and much less easily recognized on the whole, are many internal reactions that occur in emotional states. There are, for example, many glandular responses that are especially active or retarded in association with different emotions. Alterations in the flow of salivary juices are such familiar phenomena that they need but to be mentioned. In detail a deal of investigation has been done with reference to the quantity of salivary and gastric juices that are poured out in varying emotional states. Here we refer to the action of glands of "external secretion," so called because they pour their contents upon the surface of the body or upon the mucous membrane that lines the mouth and the alimentary tract.

Pawlow was able to measure the quantity of both salivary and gastric juices that flowed in a given time and in given circumstances. When a dog, eating his food, was suddenly angered by the appearance of a cat, his gastric juices quickly and entirely stopped flowing into the stomach cavity. The process was not revived until after several minutes, and even then it was only gradually resumed. In situations that, if duplicated in experiments upon human subjects, would arouse unpleasant experience, the discharge of gastric juices was retarded. For example, when the platter from which the animal was accustomed to be fed was brought empty before him, the flow of gastric juices into his stomach was slowed. The observation of glandular reactions through such experiments as these is strongly suggestive of the unhappy plight of the "stalled ox" and of the boon of the "dinner of herbs and satisfaction therewith."

The endocrine glands (or glands of internal secretion) of which we hear most in this connection are the thyroid, the adrenals and the pituitary body.

The thyroid is situated in the lower part of the neck and its activity is apparently necessary to normal brain functioning. It stores iodine in combination with certain proteins and this is the active principle of the gland. Excessive secretion of this principle and excessive feeding with thyroid produce a condition of extreme sensitivity to pain, to stimulation of any sort, to infection and to emotional situations. A sub-normal supply of thyroid produced by ligation of arteries connecting the gland, by severing its nerve supply or by excision of a part of the gland reduces this condition and restores the normal state or sets it back below the normal, in which case the subject is sluggish mentally and physically. These observations make it clear that the functioning of the thyroid is in close relation to our emotional life. An over supply of the secretion makes one liable at least to the responses of anger, fear, resentment and the like, while with an under-supply one is left cold and emotionless. These effects are produced, in part at least, by way of certain changes in brain tissue which include a breaking down of Purkinje cells and the loss of cytoplasm.

Other glands of internal secretion that play an important part in relation to emotion are the adrenals. These are two in number and they lie near the kidneys. They are closely interrelated with brain function, but the dependence is less upon the side of the glands than of the brain. This appears to be the fact as determined in experiments in which the nerve connection between the glands and the brain has been severed. The glands in such a case continue to function, though lamely, and to supply the organism with sufficient adrenalin to maintain life. The brain, on the other hand, in such a case, deteriorates until death ensues.

It appears that in states of strong emotion the adrenals are more active than at other times because these states, and those of relative quiescence that immediately follow them, correlate with the presence of unusual quantities of adrenalin that has been discharged into the blood. The first effects upon consciousness of the discharge of adrenalin are in the form of a sense of recovery from fatigue; a sense of vigor or muscular power; of eagerness and alertness. It is probable that an increase of adrenalin in the circulatory system is responsible for the sense of freedom and exhilaration on the part of the fatigued soldier, for example. When, after a hard day's march, he learns that the enemy is just over the hill and that he will soon be engaged he casts fatigue to the winds and is ready for the fray. Such consequences ensue upon the artificial injection of adrenalin and with them there occurs a slowing up of the discharge of gastric juices which, we have already seen, occurs in connection with some strong emotions.

It has been suggested that we have in the interrelation of brain and adrenals the key to the automatic action of the body. When the brain receives its stimuli through the organs of sense, energy is released in it which activates the organs and glands including the adrenals. Adrenalin is poured out and this in turn contributes to the excitation of organic activity including that of the brain and ganglia, whereupon these circular reactions continue.

In cases of deficiency in the secretion of pituitrin by the pituitary gland there is mental sluggishness and a deadening of emotional life.

Such statements as the above appear to be substantially based upon observed facts. But the so-called science of endocrinology is yet far from making good its frequent claim to possession of the key to the understanding of human personality and behavior. The recurring psuedo-explanations of criminal behavior by reference to the action or inaction of endocrine glands savors over much of playing with two unknowns (at least two) to justify the admission of endocrinology to the company of the sciences.

Theories of Emotion.—The preceding discussion of motor and other bodily accompaniments of emotion lead us naturally to the James-Lange theory of emotion.

This theory is so named from its authors: William James, the great American psychologist, and the Danish physiologist, Lange, who, working independently of each other promulgated the theory early in the 1880's. According to this theory an emotional state is a compound of many sensations, each one of which arises from one or another of the bodily processes—muscular activities or glandular reactions—that we have been describing. In everyday language we would say that an emotion is the way we feel when all these bodily processes are going on. The implication in this is that the physical processes come first and the emotion afterward. "We see the bear, we run away and then we are afraid." In other words, we may have an intellectual appreciation of the danger in consequence of which we get out of its way. But unless we have with it the sensations that arise from the bodily reactions we have been describing, there is none of that stirred up condition that we have been calling the emotion. The perception of the bear in such a case would be "purely cognitive in form, pale, colorless, destitute of emotional warmth. We might then see the bear and judge it best to run, receive the insult, and deem it right to strike, but we should not actually *feel* afraid or angry."

The crucial test of the theory must lie in the behavior of persons in whom there had been a severance of all nerve connections between the organs, glands and muscles to which we have been referring on the one hand, and the sensorium on the other. If, in spite of such disconnection, the subject continues to be stirred up in the face of emotional situations, the theory will be unsupported and conversely. As a matter of course such evidence is extremely hard to find. There have been in medical clinics a very few cases that probably illustrate such disconnection and loss of organic sensation, together with failure of emotional reaction. But sufficient evidence of this nature must be regarded as lacking.

Less direct evidence pro and con has been sought. Professor James himself instituted the search and he stated two corollaries either one of which, if supported, would at least strengthen the theory.

First, if the theory is sound, we should be able to produce an emotion by acting the part. Secondly, we should be able to kill it by inhibiting such action.

As to the first of these corollaries, it is common knowledge that if, in the face of danger we draw ourselves up to our full height, thrust out our chest, speak confidently, and in other ways assume the attitude of the courageous man, we go a part of the way toward inhibiting the fear emotion and substituting that of courage. Likewise we may work ourselves up a part of the way toward anger by acting the part. On the other hand, our courage begins to ooze away when we slink, and our anger fades when we count ten before we strike, and when we hold down the pitch of our voice. But if such observations as these are broadly significant in this connection, actors upon the stage should always experience the emotion that they are representing. It is by no means an invariable rule that they do so. True to life as the acting may be, it often leaves the actor quite cold. Indeed he is quite as likely to be greatly amused as to be even slightly angry when he is playing the part of one in a towering rage. The strong partisan of the James-Lange theory meets this situation by asserting that the actor who does not experience the emotion he is representing to his audience acts only with his external musculature: that he has got into the way of inhibiting the internal reactions of glands and visceral muscles which are most weighty among the antecedents of emotion. On the other hand, such persons as do experience the emotion whilst they are acting are those who do not inhibit either external or internal reactions. This statement is, of course, purely hypothetical at the present time.

Certain other observations that the man in the street may make suggest a supplement to the theory we are discussing. Suppose "A" is walking down the avenue when "B" slips up from behind and knocks his hat into the gutter. "A," on seeing who did the trick has immediately a series of memory images of other instances in which "B" has done meanly and he is furiously angry. On a similar occasion it is "C" who knocks off the hat and this time "A" accepts the situation in entire good humor. "C" has always been a good fellow in his relations with "A." Something has been *taken into consideration* in each instance, and this process is evidently one element in the causal chain that leads to the emotion, in one case, and to its inhibition in the other.

Emotion and Impulse.—Emotion and instinct—which some have identified with impulse—are often said to go together; thus emotion is assumed to be the conscious aspect of impulse. But this view lacks unqualified support. We often are strongly impelled to get away from danger, for example, when there is none of that stirred up condition that we call emotion—in this case—of fear. We are sometimes stirred up with anger though we have no impulse to strike or to fight in any manner. If emotion is an aspect of impulse the one should invariably occur with the other.

It is true that the impulse to get away often follows the emotion of fear. Illustrations are found in those cases in which one is said to be "paralyzed by fear." This suggests that the emotional state, in such instances, gives rise to the impulse: as if the energies released in connection with the internal and external reactions in the emotional state have radiated out and broken the bonds of other stores of energy that supply the locomotor muscles.

Again the emotion sometimes follows the impulse to get away, only after an appreciable space of time. As for example, when one, in driving one's automobile, perceives an imminently dangerous situation and *instantly* reacts (acts upon the impulse) to avert a crash. But the stirred up or emotional state does not occur till one has driven away to a place of safety.

Once aroused, this organic state persists for some time and the driver will probably be "on edge" all day and inclined to dodge every approaching car even though there may be a wide margin of safety. This suggests other familiar phenomena. The person who has been in an acute state of grief for a period of weeks will almost certainly, for a long period thereafter, possibly for years, be very easily aroused to the experience of grief and to its usual mode of expression. Slight evidence of misfortune to a friend or a neighbor may suffice for this end. Similarly one who has been for an hour in a state of mirth may be aroused to laughter at any time within a considerable period thereafter by the slightest of occasions.

These observations suggest that the emotional state, prolonged, results in the establishment of a habit: a habit of internal reaction that is in all respects analogous to the habitual external response to a given situation such as the habit of drawing on one's left glove in advance of the right. Now a habit—if we emphasize the neural arrangement that is its essential foundation—is a preparation for a reaction of a particular sort. In like manner the arrangements or structures—whatever they may be—that lie at the basis of emotional reactions may be conceived also as preparatory to other overt, or more distinctly overt, actions, such as the act of running away, of fighting, etc.

Alteration of Emotional States and Reactions.—Referring to habit in relation to emotional reaction brings us to consider the possibility of modifying emotional responses to familiar situations and of establishing new connections of response and stimulus. The laws of learning or of habit apply in relation to emotional responses as they do elsewhere. The most harmless object may become a fear stimulus if certain antecedents are provided. There is the story of the fireman who became so fearful of inert telephone poles that he could not pass one without a shudder.

The antecedent of this situation was very simple. When he was racing on the hook and ladder wagon to fight a fire the wagon swung around so that he had an escape of but a hair's breadth from being crushed to death against a pole. He was in fact seriously injured. After his recovery from his bodily laceration his fear reactions persisted.

The young woman lodging adjacent to the hospital in which her mother lay at the point of death for a long time prior to a serious surgical operation and subsequently came out of the ordeal with a fear of church towers and church bells. During all the weeks of her apprehensive and mournful vigil she had been disturbed by the hourly tolling of a church bell near by, and to that kind of object her emotion was, in the course of time, transferred. The emotional reaction of sensitive folk toward the fetish and the totem is a case in point. Here are emotional transfers that, in all essentials, are like the cases we have described. A religious emotion is elicited, not by what we would ordinarily call an adequate situation—in this case perhaps a mental image of an idealized person—but by a block of wood or stone. And once more—to take an extreme case—the phobias of the mentally disordered; a state of fear has arisen; the patient knows not why he is fearful, but by and by he begins to attach his fear, so to speak, to an object that cannot by any means be properly interpreted as justifying a fear reaction. The patient begins to fear open spaces or closed spaces; or he fears to touch with his bare hand an object such as a door knob. Or, to take a more familiar illustration within the scope of what we may call normal experience, he fears the number thirteen.

These are, for the most part, extreme instances, of course, that have had their rise in abnormal conditions. They are, however, in all essential points, analogous to the conditioned knee jerk, for example. The adequate stimulus for this reaction is a tap upon the lower edge of the knee cap.

But if a bell be rung simultaneously with the occurrence of successive taps, and if this double stimulation be repeated with sufficient frequency for a period, the knee jerk will invariably occur upon the ringing of the bell alone. The principle of these phenomena has in it the potentiality of a broad training of the emotions; that is, of alteration of emotional reactions; of associating them with new objects or of inhibiting them in the face of old objects.

Higher Emotions.—This brings us to the so-called higher emotions as contrasted with the primary emotions of fear, hate, grief, love and the like, when they are produced by what we have called adequate stimuli. The higher emotions are not really ''higher.'' They are aroused merely by different objects than those that incite the primary emotions: by subdued rather than by bright objects: by ''quiet'' rather than by ''loud'' ornamentation of the person: by subtle, rather than by coarse humor. And beautiful paintings upon the wall come to elicit the emotion of love or of fear as does the real situation in nature that the painter has represented in mere line and color upon his canvas.

So emotions are modified by the forming of new attachments of the emotional reaction and by toning the emotional behavior up or down. But not only so. For two or more emotions combine to form a compound as pity is a combination of grief and tenderness; or hate, a combination of anger and fear.

In all the foregoing we have been emphasizing the association of emotional reaction with objects in the sense of persons and things in the material world. But ''objects'' are ideas and ideals also. There is no possibility of separating the organism and of placing ideas and ideals in a compartment by themselves over against other objects. There are religious emotions, for example, that are occasioned by contemplation of idealized persons and of themes that have no counterpart in wood and stone and flesh. Indeed, it is fair to say that the idea factor in one case and the ideal element in another is never quite absent from an emotion-arousing situation.

It is with relation to those instances in which the emotional situation most emphasizes the idea or the ideal that many persons speak of the sentiments; as in the phrases "the sentiment" of pity and "the religious sentiments." These are emotions, although, like other so-called "higher emotions" they are mild as compared with the violent emotion of grief and anger and the like—the so-called "primary" emotions—and their mode of expression lacks the violent character of the behavior of an angry man.

The Genesis of Emotional Expression.—We have been thinking of many ways in which the emotions are expressed by internal bodily reactions that do not lend themselves readily to observation. At the same time we are familiar with certain reactions of the skeletal muscles that cannot escape observation, such as the snarl, the redness of the face, and the tenseness of muscles that occurs in anger. The question arises—what are all these reactions for? We are becoming accustomed to thinking of internal or implicit—as opposed to overt or explicit—responses in emotion as preparatory to adjustment of the whole organism. Perhaps these others are likewise. The hypothesis is attractive, at any rate, and plausible, in relation to the tenseness of the muscles in anger (preparation for striking) and in fright (preparation to run away). But the snarl and the like appear to be in a different category.

Darwin, in this connection, has advanced the theory that here we have remnants of reactions that in the long-past history of the race were useful but that have long since ceased to be so. And he fortified his theory by observation of men of widely different status in widely separated quarters of the world, and of lower animals. The dog's snarl is useful amongst animals because it exposes his teeth, the weapons with which he fights, and so makes him the more formidable antagonist. The growl of animals and men serves the same purpose and so does the reddening of the face in men and their drawing themselves up to full height. On the other hand the cowering, slinking attitude and the unsteady gaze in fear makes the animal appear less formidable and may indirectly facilitate escape because, lacking formidability, the enemy may pass him by rather than waste energy upon him. Those animals—so the argument runs—that possessed the capacity for the types of reaction referred to, had the opportunity to survive and to pass them on through biological inheritance to their successors in the long chain of evolutionary processes. And so we have in ourselves these traces of by-gone ages. They are no longer of use to us—the snarl, e.g., the distended nostrils, the reddened face, and the growl—indeed, they are an embarrassment; and in cultivated social levels we do our utmost to inhibit them.

Emotion and Health.—It has come to be accepted as a matter of course that our emotional reactions have a close relationship to mental and bodily health. It will be clear, in the light of this chapter that the relationship is not wholly a fiction.

First, as respects bodily health. Certain emotions go along with a normal flow of gastric and salivary juices and others with a slowing or even a stopping of the process. Digestion at least, consequently, will be accelerated or retarded according to the emotional state, and it is conceivable that if this state be long-continued, a serious, even chronic disorder of the digestive process may ensue; or conversely, the process may be chronically toned up—depending on whether the emotion be one of depression or the reverse. By the same token states that accompany a normal functioning of the thyroid, and those that go with its retardation respectively, build up or tear down bodily health.

The foregoing is even more true in relation to mental health. In a state of depression, for example, we inevitably dwell upon our misfortunes, real or imagined. If such a state be long enduring, the habit of entertaining gloomy thoughts of inadequacy will ultimately become fixed in a picture of the melancholiac or of the victim of an inferiority complex. Furthermore, a long-continued period of depression fatally fixes in attention the trivial adversities that are one's normal experience. It is an easy process, then, by way of rationalization to build up a fixed delusion and to defend it. This is apparently the history of many a persecutory delusion of the insane in which the memories of having been punished in school, spanked at home and trounced by a boyhood playfellow are woven together with products of imagination and terminate in the belief that every thumb is down against the subject and always has been so.

But to come nearer home to the experience of every one of us: a prolonged state of emotion, exalted or depressed, breeds a corresponding *mood*. Witness the effect of long-drawn-out grief. For a long time—possibly months or even years—after the acute stage has passed, the sufferer is peculiarly sensitive to grief-provoking situations. His neighbor's slight adversity provokes him to tears. And the converse, by the way, occurs after a prolonged period of acute joy. These are *moods*. They are analogous to *temperament*, in a respectable sense of the word; the difference being that the one is acquired while the other is believed to be innate.

Recurring, now, to the thought of unhealthy mental states, there are observations, some casual and others controlled by the conditions of clinical method and experiment that support the proposition that the recovery of mental health, and physical well-being too, may be at least greatly facilitated by arranging the total situation in such a manner as to arouse, and to keep foremost, thoughts of pleasant relations.

Training the Emotions.—In the light of the foregoing the importance of training applied to emotional reactions will be apparent. This for a three-fold reason: (1) the interrelation of emotions and physical health. Good digestion waits upon a favorable emotional tone; (2) their bearing upon mental health. Damning prejudices, obsessions, delusions and "mental kinks" are superstructures upon a cornerstone of emotional disorder; (3) because of their social effects. We are living, not alone, but with a host. We cannot escape our neighbors. If, for purely selfish reasons, we are desirous of obtaining their aid to help us attain our ambitions, we dare not make ourselves unseemly in their eyes by our emotional idiosyncrasies. If we are would-be helpers rather than obstructionists an untoward explosiveness on our part may throw a wrench into social machinery. In a period so complex as ours the most desirable ends of individuals and of groups are reached, not by explosive slap-dashery but by quiet consideration of methods running along with a habitually frank, open enjoyment of social intercourse.

All these motives are worthy and besides there are aesthetic ends to be attained through emotional control. There is beauty in behavior as well as in color and in line.

The training of such capacities as memory, reason and perception has, till now, occupied so prominent a place in our social economy that emotional reactions have received only casual attention. Fortunately the traditional emphasis is not without its bearing upon the emotional set and expression. This is probably due in considerable measure to the anatomical and functional relation of the sympathetic nervous system to the central organization so that the activity of the central system, in a measure, directly affects the sympathetic. Inhibitions and incitations of emotional reaction occur, therefore, somewhat as a by-product, from the plane of voluntary action and thinking. For this reason there is undoubtedly an exaggeration in the emphasis that emotional training, *per se,* is receiving at the hands of certain enthusiasts.

Nevertheless, there is possibility and justification for such training in its own right and its fundamental principle can be no other than that of training in general: the principle of habituation. Let the learner be "schooled" to express his emotional reaction to objects that please the eye and ear and to those that displease. And let him understand the inefficacy of violent outbreaks of primitive emotional behavior to the end that he may acquire the habit of inhibiting them. The "self-expression" fetish is a worship of Nietschianism at its worst, reënforced by the unscientific, because mystic, proclivities of the Freudians. Nobody does or can live alone, excepting Robinson Crusoe, and even he had his man Friday. For the reason that hosts of people are living elbow-to-elbow it is quite as necessary to apply the brakes every day to our personalities and even to keep them on in spots (so long as we do not make a "shut-in") as it is to open the throttle. If we were all alike, and if we were all altering ourselves synchronously we need not talk of training the emotions. But we are not.

CHAPTER XII

INSTINCT

> "Although reason may—in varying degrees be blended with instinct, the distinction between the two is sufficiently precise; for reason, in whatever degree present, acts only upon a definite and often laboriously acquired knowledge of the relation between means and ends."—Romanes

Confusion in the Use of Terms.—The terms "instinct" and "instinctive" are so widely used in popular and semi-popular speech and writing that one should think no misunderstanding could arise respecting the connections in which they may be employed with propriety. But misunderstandings are only too apparent in relation to these troublesome words. "Instinct" is sometimes used to refer to a form of action, and again to what is conceived as lying back of that action and predetermining it, as it were. It is often applied to what the technical student describes as a simple reflex like the winking of the eye or the act of swallowing. Yet again it relates to a firmly fixed habit as when one says: "the engineer by *instinct* closed the throttle and applied the brakes." In like manner the adjective "instinctive" and the adverb "instinctively" are often employed. But it is not only in the language of the street and of the semi-popular press that this loose usage obtains. It is apparent too in the work of many psychological texts, and it occasions much confusion of thought.

It is necessary, first of all, to clear up this confusion by adopting a usage and then by sticking to it consistently. Obviously the term in question must not be used interchangeably with reflex or with habit. If such an interchange can be properly made then reflex and habit on the one hand, or instinct on the other, is a superfluous addition to our vocabulary. Only less obviously should we avoid using the noun to refer simply to a form of behavior. Because whatever else may be connoted by the term "instinct" psychologists have meant by it something that has persisted unchanged throughout the whole history of the animal kingdom till now, and that will endure for all time to come. But such overt forms of behavior as the nest-building activities of birds, and many other forms of animal behavior that are often classified as instincts are, according to reliable observers, open to extensive modifications, and some of them even to modifications that, in extreme instances, amount to elimination.

What we want to imply by the terms in question is a native or natural equipment of an animal organism. It need not imply an equipment of structure in the nervous system. It is rather to be understood as fundamentally an endowment of potential energy or motive power; as a potential *drive* or impulsion. It comes above the level of consciousness only vicariously in the form of sensations and feelings, when it has become kinetic. It makes itself known in bodily adjustments; and perhaps usually in only incipient adjustments or preparations for activity. When this drive works through very highly specialized organs, independently of learning, we have a picture of instinctive action. It is as sensible to ask for its origin as to inquire for the source of our blood.

As a potential energy it "wants" to do something, in the sense that water "wants" to run down hill. So the organism is *impelled* from within to seek companionship; to avoid danger; to fight. *Evident* external stimulation is not a necessary prerequisite.

Some psychologists seem to hold that there are many specialized *drives* and that these are so many instincts. Such students suggest the hypothesis that the total energy of the animal organism is divided in the last analysis, amongst many non-communicating compartments; that each compartment is sufficient unto itself; and that there is a peculiar *form* of energy corresponding to every instinct. Just this appears to be very nearly implied, especially in some of the older conceptions of instinct. And the view has some currency to-day. It brings us very close again to the old "faculty psychology" with its implication of a divided rather than a unified organism.

Definition.—Instinct, in the sense in which we are using the term then is the energy of the animal organism; an impulsion or drive. More than this, it is this energy or drive *working through organs of high specialization toward the satisfaction of specific organic needs, and without the influence of learning.*

It does not invariably require an *external* stimulus to release it as the nervous energy in the retina demands an external light-stimulus to make it effective. On the contrary the condition of the organism as a whole—an internal situation—may release the drive; when, for instance, the organism is in the state described by the adjective "hungry" there is a going about to seek for food. The drive is universal in the animal kingdom, and unalterable. It becomes effective through such organs and other devices as are present by nature or through acquired habits or "sets," and such as are "open" by reason of the situation that confronts the organism at a given time. The running mechanism, for instance, is "open" in a situation that may be described as frightful. So one does not run merely because of an *instinct for running* but because one has a mechanism for running. The squirrel will be active in climbing trees *not merely because he has an instinct for climbing but because his equipment of muscles and claws is* *a suitable outlet for his drive when he is playing and escaping.*

There are many degrees of "openness" amongst the "organs and other devices" referred to. Organs for defense, food taking, sex activity and a very few others of an equally high order of specialization are so wide "open" that, given a suitable situation, they will be active at once. There is such a fatality about this that, to an outside observer, it looks as if there were several specific instincts in men each of which is a *specific energy* working through appropriate bodily organs toward a specific end. Lower animals and very young children present the best and most numerous examples of the "openness" we have in mind. Certain mechanisms (like those for food-taking and vocalization *e.g.*) are open at the beginning of human infancy; others, like that for sex-activity, are not so. For this reason we recognize instincts that are present at birth and others whose development is delayed. The drive is there but the mechanism is absent at the outset.

The more complex the organism and the more numerous in consequence are the natural and the acquired outlets through which the energy of the organism can be discharged; the greater the number of possibilities for outlet, the less likely is it that any one given avenue alone will be "open" in a particular instance. Behavior is then much less predictable than in other circumstances.

The drive is above the level of consciousness only vicariously in the shape of organic and kinaesthetic sensations and as ideas and images, desires, etc. These elements are always present because of the avenues through which the drive is effective; that is through the muscles and organs of the body. In overt action the organs are in appropriate movements and we *sense* the movements. When we are incipiently active also (preparing for action) we are aware of muscle tensions and of desires, etc. The drive, we repeat, is above the level of consciousness only in such forms as these. These forms fall into patterns so that *on the whole* all men fight in the same manner and all act in the same manner when they are frightened. From two such patterns as these we are likely to infer two instincts or drives; all the more so because the two patterns do not feel alike. When we observe the activity of another organism and see its closely knit patterns of behavior that, so far as we can discern, have not been learned by the individual we are likely to infer that there are as many specific drives as there are patterns.

So instinct is a native drive; it is effective only through certain physiological devices; it is above the level of consciousness only as sensations that arise from the use of these devices and as ideas, desires, etc.

From this point of view one would say of the ''fighting instinct'' in a description of its operation in a particular instance: ''The drive is above the level of consciousness. It is running along with organic and muscle sensations that arise from those organs and muscles that are active in fighting. It is associated, too, with ideas and images of the ends that may be gained from fighting. The sensation factors, in this case, loom very large and they arise from many organs.''

Of the ''instinct of curiosity'' one would say, again, that the drive is above the level of consciousness vicariously, as ideas and as thought about the object of curiosity. The sensation elements are here, too, because curiosity has a motor aspect. It is a state of bodily preparation for prying into something: a state of incipient action. Hence it comes that there are motor tensions associated with the curiosity-behavior. These tensions provide the sensory elements. But perception of the object of curiosity and some reflection about it are the things that stand out when we are describing curiosity.

In an attempt to describe any other instinct we should speak in an analogous manner. In every case, when one is describing one's own instinctive behavior, one will have to set down a catalogue of various sensation qualities, of images, ideas, desires, etc., all variously compounded. The instinct is the drive *plus* organic coöperation of a more or less high degree of invariability. Observation of the examples we have chosen above will not proceed far before we discover the possibility that a wide range of organs may be active in fighting and in curiosity. There is little specificity and consequently little of the instinctive element involved. *It is the same drive in the one case as in the other.*

Striving and Desire.—From some quarters *striving* and *desire* are being put forward in the literature as substitutes for *instinct*. Each of these possesses merit in this connection. From the point of view that is favored in this chapter, **striving is another name for the drive above the level of consciousness.** The goal of striving is not sharply defined. It lacks concreteness. Desire, too, **is the same drive, well above the level of consciousness.** Its goal is well defined and concrete. In each case it is the drive, again, become conscious—or rather associating with conscious factors—among which the idea of an end is the prominent element and it *seems* to be providing the motive power.

Mechanical Conception of Instinct.—By the subject of this section we mean to suggest a certain invariability of outlets for the drive. The steam from a boiler acts with mechanical precision, we say, because it always follows the same course from the boiler to the cylinders of the engine and out through the exhaust. On its way, we observe, it always turns the same set of wheels when the situation is suitable; that is, when the pistons and wheels are not locked, and when the gears remain unshifted from day to day its behavior is constant.

We have already pointed out that there are degrees of instinctiveness because there are variations in the specificity of organs and in the fatality with which forms of behavior occur in response to a stimulus. In some forms of human behavior, and in the activity of lower animals on the whole, the instinctive factor looms large; in others, small. On the whole, in the human family, this element becomes progressively smaller and smaller and of less and less importance from infancy to adulthood.

We have said that in some forms of human behavior the instinctive factor is greater than in others. In the act of eating our food, for instance, it is greater than in the act of writing a letter upon a delicate subject to a sensitive correspondent. In eating we proceed with freedom and precision. Day after day we eat the same kinds of food, approximately and in the same manner. In writing the letter, on the other hand, we go cautiously. We halt, retrace our steps, make erasures and go ahead. There are many other factors here than just instinct and a smooth course. The latter act is less instinctive than the former.

Indeed in even the most instinctive of forms of human behavior there is much less fatality or mechanical precision than there is usually assumed to be.

There is more or less cutting and fitting of means as if to an end. For example, we talk of the fighting instinct, but we may fight by using our fists, teeth, finger nails, clubs or guns. Which of these instruments we shall use, or whether we shall employ all of them together, will depend upon the total situation in which we find ourselves at the time of fighting. Not only so but we may, excepting in extraordinary instances, proscribe every one of these implements; we may have not so much as an inclination to use one of them. This situation actually comes to pass in a highly civilized state of being; we then *compete* with one another according to the ethics of commercial and professional life.

But this is not all that at present obstructs an out-and-out mechanistic theory of instinctive behavior. Two or more highly instinctive acts sometimes use the same means of expression. For example, when an animal is fighting he behaves, in many details, as when he is running away in fright; and when a man is expressing a so-called instinct of self-abasement, too, he is behaving much as if he were running away. It is safe to say that any given set of muscles may be employed in any instinctive act just as the vibration of a person's vocal organs may extend over a telephone system to any part of the city, depending upon the ways that are opened by the central operator.

Instinctive and Reflex Activity.—Forms of behavior in which the instinct factor looms high suggest alliance with the reflex. They appear as a series of reflexes. Walking, for example, may be described as such a series. Once a foot has been placed upon the ground, the stimulation of sensory organs in the sole serves to set off, reflexly, the forward swinging of the other foot. As soon as it receives its quota of impressions from contact with the ground the first foot is set swinging and so on till an end is reached at which the customary stimulus no longer pulls the trigger.

The reflex does not repeat itself in this manner. Its mode of setting off is similar to that of an individual step in a series. But when the right hand has been reflexly jerked away from contact with a hot stove, and when it has come to rest, the left hand does not catch the cue from the muscular and other sensory processes that arose a moment before in the right. It remains inactive, excepting for convulsive movements.

Furthermore the reflex act is performed with a deal more of accuracy than even the most highly instinctive forms of behavior.

These distinctions are of an arbitrary character, but such as they are, they are generally held.

Purposive Character.—The difference between the walking behavior, described in this manner, and the simple reflex jerking one's finger away from a hot stove, is one of complexity alone. But there is more in walking than has been indicated here. There is a certain "set" or disposition of the walker's organism that is expressed by his *wanting* to arrive at a destination *in order that* he may keep an appointment. Once he has arrived, the walking will cease. There is nothing of this in the simple reflex removal of the finger from the stove. There is at least a persistence about what is called the instinctive behavior that does not appear in the reflex. The so-called instinctive seeking for food on the part of a hungry man would doubtless be a better illustration than walking, but for the fact that, for the most of us, it is an unfamiliar experience.

All of this suggests a purposive nature of the instinctive act. Of course, in a sense, all behavior is purposive—if it accomplishes something. Certainly from the viewpoint of the casual observer everything that a bird does in process of building a nest might have been chosen *in order to build a nest.* In other words, one can see how building a nest might be interpreted as purposive in the sense in which that word has so long been used by the psychologists. The complex act of building is purposive in the sense that somehow all things fit together toward the ultimate completion of a nest. Not only so, but the building of a nest, and other similar forms of behavior, do not appear to be eternally fixed processes in all details of placement of sticks and straws, pieces of string and bits of cloth. The careful observations by Swindle upon the building operations of birds supports the foregoing; and the Peckhams have shown that the solitary wasp, stinging its prey, does not invariably pierce at the same spot in successive instances. The end is accomplished, but, in these cases, by variant means. In details the operation is suited to the surrounding circumstances. In this respect, too, from the observer's viewpoint, the process of building appears to be purposive, but no reliable observer would assume that the bird, for example, makes an analysis of this situation and that it compares materials in the sense in which a human builder does. All that the most ardent and extreme supporter of the purposive character of instincts can assume is a persistent pushing from within till certain objects shall have been attained. In terms of human consciousness, it is a *sense of wanting* those objects or ends —and a wanting, at that, that has not resulted from teaching or learning but has arisen from the original nature of the organism. Speaking again from the viewpoint of conscious life, these wants are conceived as providing a color, or an atmosphere, by reason of which certain forms of behavior seem worth while and are agreeable, whereas other forms are not so.

Modifiability of Instinctive Behavior.—The foregoing brings us to a consideration of the changes that instinctive behavior undergoes in the course of development. If we assume strict accuracy for the statement that an instinct is an inner urging or impulsion toward the attainment of an object, it would be impossible to show that it undergoes any modification whatever.

It would probably be a safe hypothesis that such instincts as there may be, in that sense alone, are unmodifiable. But certainly instinctive behavior undergoes profound alterations.

One of the best illustrations upon this point is found in the work of W. E. D. Scott upon the singing of birds. The bobolink, oriole, and robin, when reared in the fields, develop songs that are characteristic of the species. In other circumstances, however, it appears that no characteristic song would develop. When orioles were segregated before they had heard the songs of their kind and were kept in isolation during several years, they became good singers but their earlier utterances were dissimilar to those of the free birds of their kindred. During certain seasons they sang almost incessantly. "It was now a loud, clear series of notes of great brilliancy, poured forth in such rapid succession as to be like that of the house-wren, and lasting about as long as the warble of the wren. Except for the rattle, which was now and then a part of the repertoire, this song had nothing in it that reminded one of the song of the Baltimore oriole as heard in New York, Massachusetts, or at any other point where the birds occur. When orioles six days of age were shut up with adults that had been brought up in isolation they began at the proper age to sing the songs of their companions. When birds belonging to fifteen or sixteen other species were brought together and reared within hearing of one another's voices, more or less modification of songs occurred. Some birds resisted these social influences more than others. The robin and the wood-thrush each developed a song that was not original. A red-winged blackbird crowed constantly during two months in the year in imitation of a bantam rooster."

A second experiment of similar import was made by Conradi upon a group of young English sparrows. Canaries with their song were an important element in the experimental situation. The sparrows were reared from incubation in the same room with the canaries and were isolated from others of their kind. The regular sparrow chirp developed at the proper time but the birds soon lost this form of expression and assumed the peep that is characteristic of the young canary. At the age of three and a half months one of the sparrows "constantly chimed in with the canaries in his own fashion, giving a low note followed by a few high ones with now and then some slurring from a high to a low note similar to those that the canaries have in their overtures. He joined the canaries freely for a few days, after which he became ill and was silent for a week.'' A fortnight later he resumed the foreign language. In general, the song in the mouth of the sparrow resembled the confusion of notes that filled the room when the three canaries were singing together at their best. Other sparrows, observed under similar conditions, much more closely approximated the vocalization of the canaries. When these sparrows were returned to their own kindred they soon assumed the ways of the English sparrow, but they still retained traces of their earlier training which Conradi was able to observe after a few months when the birds were recaptured. Their voices were still more musical than those of untrained sparrows and when they were returned again to the canary environment they soon regained what they had lost.

Outside of the laboratory illustrations abound of the modifiability of instinctive behavior. The fear reaction, for example, has all but disappeared from domesticated cattle, horses and sheep; so much so that these animals—many of them—far from running away at the sight of their master, will bound to meet him and follow him across the meadow, the while affording abundant signs of satisfaction.

Such phenomena as these are serviceable because of the emphatic demonstration they afford of the modifiability of what we have called instinctive reactions. What are sometimes interpreted and described as highly specialized instincts, are in reality habits based upon natural impulsions toward activity: habits developed by repeated responses to the varied angles of the day's work. They suggest that a fundamental drive or instinct lies at the basis of our nature that is much less differentiated than we have heretofore customarily assumed it to be. There may be, for example, an instinct that consists in an inner urging toward vocal expression; one that is assumed to rest upon a heritable biological basis. How this foundation will make itself known—what notes will be sung and in what combinations—will depend upon the stimuli and situations that play upon it.

Many of the modifications of instinctive behavior amount *practically* to an elimination of instinct.

The modification of instinctive behavior is an affair of the sensory-motor arc. It is a case of establishing close synaptic connections or of breaking up old ones; of altering bodily organs by use or by disuse. In other words it is a case of changing old habits or of building up entirely new ones as substitutes for old ones.

The sight of a dissecting room, for example, once aroused the medical student to a shuddering reaction, to incoördination and to confusion, but it does so no longer. On the contrary, after some professional contact with the room, it leaves him quite cold and indifferent; or it provokes a new reaction—a substitute for shuddering—such as thinking upon a problem in human anatomy. But instinct, doubtless, has not been completely killed in most of such instances as this, although as far as *practical* consequences go it amounts to nothing. At the most it hangs on very much as another instinct persists in the "perfectly controlled" man who tells us that nearly every day he has to "count ten" and inhibit his speech to prevent an angry outburst.

The modifiability of instinctive behavior has very important social consequences as we shall see later.

Classification of Instinctive Acts.—Because behavior presents an indefinite number of degrees of instinctiveness and because it is constantly undergoing modification, a classification of instinctive acts presents extraordinary difficulties.

The following is a typical classification:

I. Individualistic or self-preservative: including all those so-called instincts, the apparent purpose of which is to promote the health and safety of the organism;

> such as the instinct to seek food and shelter; to avoid danger; to accumulate a store of food and nesting material, to name a few.
>
> II. Adaptive: including all those so-called instincts the apparent purpose of which is to become acquainted with one's own powers, capacities and limitations, and with other individuals of one's sort to the end that an adaptation may be effected; such as play by which one is assumed to learn to apply one's powers in the varied processes of adaptation to one's environment; imitation and curiosity by which one indirectly adapts one's self to other individuals and things.
>
> III. Social: Such as the gregarious instinct which impels us to associate with others of our sort.
>
> IV. Racial: Such as the mating and parental instincts, the effect of which is to preserve the race.

Clearly this classification is not based upon the characteristics of instinct but upon its effects; or upon the modes by which instinct expresses itself. It could be indefinitely expanded and there is a strong temptation to expand it when we are confronted by a form of behavior that puzzles us; it is so easy to call it evidence of a specific instinct and to assign it to a place in a scheme like this! It will be sufficient to group all these forms of behavior as follows:

1. Those that result in the satisfaction of organic needs.
2. Those that result in the satisfaction of social needs.

In these cases the fundamental thing, in the last analysis, is the satisfaction of organic need. In the first group there is expression of drive in such activities as eating and drinking; protecting one's self against heat, cold, and danger to life or limb; in sleep and curiosity (considered as an urge to be at ease with one's physical surroundings) and in mating. Those activities that are preparatory to the satisfaction of these needs, such as going in search for food, drink or a mate; or as building a house that will protect us, we have shown at the outset, are not instincts. They are instinctive *acts* that vary in form from time to time to suit the special circumstances of the moment and that ultimately become crystallized as habits. Many other acts such as shrinking from the cold, dodging the blow and swallowing the food that is in the mouth are simple reflexes or automatisms, not instincts.

In the second the outlet is in our initial setting out toward the achievement of social relations with others of our kind. This results primarily in our entering into a group, and it may conclude in play, imitation, curiosity (in this case considered as an urging for acquaintanceship with others); in fighting or in mothering according to the surrounding circumstances. In these cases, too, the reactions, in time, become crystallized as habits.

Many other forms of behavior that we have passed unmentioned are highly instinctive. These are, for example; locomotion, vocalization, manipulation and laughter, to name but a few. Each of these is a means of satisfying an organic need, it may be, for physical activity regardless of what is to be attained thereby. Suppose there is regard, in any instance, for an end to be accomplished, the activity is instinctive but it is more or less remotely so. ''More or less,'' we say, because relatively the criteria of instinct have taken a back seat. They have been clouded by something different. In the last instance, that of laughter, the activity is probably always mainly instinctive. It satisfies the organic need for relief of certain inner tensions through the activity of very highly specialized organs.

Undoubtedly the ''purest'' illustrations that we have of instinctive acts (that is, acts of the highest degree of instinctiveness) are those that are found in our methods of satisfying very definite organic needs. Wherever there is an organ that figures with peculiar definiteness in relation to adjustment there will be a group of reactions of a highly instinctive character. The organs that perform the definite function of eating and alimentation for example are the avenues for the highly instinctive acts of taking food. All such acts are associated with vivid emotional and sensational experience. This situation, by the way, is by itself a considerable barrier against modifying and suppressing influences.

On the other hand, organs that figure less definitely—that is with reference to a wide range of acts of adjustment—are the avenues of acts of less pronounced instinctive character. The behavior of the human hand, for instance, is instinctive, but the instinctive element in it is covered up by countless accumulations of habits that have been gained through manipulation of things, by play, construction, imitation, etc. And just because the hand is active over a very wide range its behavior of playing, constructing and all that is especially subject to modification.

The Function of Instinct.—The primary function of instinct is to take care of first adjustments. It accomplishes this by using what mechanisms the organism possesses. It has survival value because in the first instance it impels the individual to take food and to withdraw from injurious situations, etc. After that its great function is to afford an immediate coloring of like or of dislike to certain lines of activity. Thus it affects our interests and therefore our thought-out and our involuntary choices of forms of behavior. It follows from this that what instincts we have will determine in a very general way what great complexes of habitual modes of satisfying our organic needs we may form. Furthermore, instinct has a relation to the development of our social life.

For if we are all equipped with the same fundamental nature that is reflected in the organization of systems of habits and conventions that are largely held in common by the members of a group, there is in this equipment a basis of mutual understanding that contributes to a development of a sense of social unity or of belonging together. This sense of unity is the *sine qua non* of effective coöperation among the members of a group. If it is not present when it is required it must be developed.

To bring it into being in normal circumstances is not merely a case of stirring up a so-called "gregarious instinct." It is the work of a long period of living in a community; of observing one another's reactions to hundreds of situations; of observing others' reactions to one's self and conversely. In the end the members of the community feel acquainted with one another. A feeling of belonging together has arisen, and coöperation is assured—given something to work for. If the group members are different as to race and nationality, and if religious and other prejudices are rife the program is not altered in the least thereby. Its execution is only the more difficult. Plays and games and all other forms of contact among persons are effective in these relations.

Reflection upon this tremendous social problem of developing a sense of unity and a readiness for coöperation will convince one that, whatever instinct may play a part in the process, it is a small part at best. Indeed there is so little of the formal and the cut-and-dried in the process that it hardly fits at all into a picture of instinct.

In the abnormal situation of war the case is somewhat different. Appeal can then be made to fear and to motives of defense against danger for quick results. Here, in relation to a social problem, one can make a claim for the efficacy of instinct. But it is temporary. Once the war is over the work of building has to go on again by all tedious methods.

Conclusion.—Ultimately our habits and conventions and acquired occupational and professional dispositions, ideals and thinking assume enormous proportions compared with those forms of behavior that are highly instinctive. The daily behavior of the civilized adult, therefore, is only very remotely traceable to instinct. Practically, instinct has been supplanted by the impulsion of habit, and other acquired activities.

As a matter of fact instinct is being incessantly and voluntarily denied. Our natural likes and dislikes are being pushed aside. The young man and the young woman determinedly resist the inclination to pledge themselves to each other, because they have acquired an ambition for success in a wholly artificial business or profession that takes precedence over everything else: an ambition that must be on the road toward satisfaction first of all. We daily deny ourselves natural delights in roving about; in hunting, fishing and playing because, as we put it, there is more serious business afoot. **Whatever we may do after awhile we will for the present satisfy an acquired desire. The promptings of instinct may wait.**

The situation is quite different with lower forms of animal life. There instinct reigns almost supreme, if not wholly so.

It is here, at least, that lower animals (and very young children of the human species) differ from adults and near adults of the human family. The highly instinctive factor stands out prominently in the behavior of the former. The instinct is of primary importance relative to the control of behavior for the former. In the behavior of the latter it is of distinctly minor value.

CHAPTER XIII

VOLUNTARY CONDUCT

> "We find in ourselves a power to begin or forbear, continue or end several actions of our minds and motions of our bodies, barely by a thought or preference of the mind ordering, or, as it were, commanding the doing or not doing such or such a particular action. This power is what we call will."—John Locke

The Volitional Situation.—Reactions of the voluntary type were discussed in a preliminary way in Chapter III. We distinguished, roughly, between reactions which follow promptly upon the stimulus and those which emerge only after a period of time given over to the selection and preparation of the appropriate response. In this chapter we take up voluntary action once more, with the object of gaining a more adequate comprehension of its workings and of its general significance.

But all of our studies of the conscious processes have been concerned with reactions of the delayed type. For all conscious activity is preparatory, selective, anticipatory, and—on the physiological side particularly—connected with the associative processes which intervene between stimulus and response.

The volitional situation, to which we now direct attention, is one in which the selective and preparatory aspects of consciousness become especially prominent. Such situations arise when the individual, confronted with two or more alternatives in the way of possible conduct, pauses in order to *decide* which course shall be adopted. The situation is one of stress and strain, of conflict between impulses, of indecision or hesitation. Such crises are familiar events in everyday life and, by reason of their obvious characteristics, have always attracted the attention of students of human nature. The modern drama may be fairly said to turn upon the volitional situation. It is central in all consideration of morals and religion. It is interesting to observe that, long before the emergence of modern psychology, students of ethics had marked out the volitional situation as crucial for their science. It is mainly because of their efforts that the subject of volition occupies the leading place to which it is now generally assigned in studies of the human mind. The process of *deciding,* indeed, is of the highest importance for any science that treats of *values,* since choice implies value in the making.

Characteristics of the Volitional Situation.—The phase of the conscious process with which we are now concerned, then, is that in which a definite choice is presented, attended by indecision, and followed by a process of analysis and evaluation through which decision is reached and action initiated.

It is to be observed that in this situation the possible alternatives are *definitely presented,* and as definitely weighed and considered. We must distinguish between such situations and those which involve a mere conflict of uncoördinated impulses. Thus one may, in the course of a walk, stop and hesitate before a mud puddle, making tentative movements this way or that which reveal the lack of reflection rather than its presence. But when the person stops entirely, considers and weighs the possibilities of the situation before him, and finally takes definite action, voluntary choice has been made. And, again, let us observe, the process of deciding is frequently preceded by a problematical situation whose outlines are far from definite.

It is not until the possibilities of the situation have been ascertained, by attentive study, that they can be presented in the form of several definite alternatives in the way of action. But we have already treated of the work of the conscious process in its task of clearing up the vague and uncertain, and must now center our attention upon the deciding activity which leads to eventual response.

We find, then, that (1) two or more possibilities in the way of action are definitely presented, that (2) they are scrutinized as to their implications as forms of activity, that (3) they are evaluated and compared with respect to the values which they may secure, that (4) they are finally balanced and a conclusion reached, that (5) indecision merges into action.

The Presentation of the Alternatives.—The necessity of making a decision between two or more alternatives is always thrust upon us by circumstances over which we have, at the time, no control. I may go or stay, I may accept the new position or remain where I am, I may have pie or ice-cream, I may be hanged or shot, I may sleep or get up. I cannot, under the circumstances, do both, or neither. The situation holds up its inexorable *either* . . . *or* and there is no escape from the disjunction. It is not surprising that Bosanquet puts the disjunctive proposition at the apex of judgment-forms. Sometimes, indeed, we try to avoid decision by finding some way to adopt both or escape both of the alternatives. Where this can be done the necessity for choice disappears. But our present concern, once more, is with the process of decision.

The alternatives are, for our situation, exhaustive. Choice must be made—there is no middle ground. The first reaction of a person confronted with such an issue is, of course, to assure himself that the situation does, in reality, require the adoption of one of the alternatives and the rejection of the other. In this process of understanding the alternatives, of testing them as to their reality, their nature is made explicit and definite.

The Scrutiny of the Alternatives.—Before a choice can be made, the alternatives must be investigated. I may do either X or Y. What does X, concretely, involve in the way of action? What *kind* of performance is it, what preparation must be made for it, what steps followed in carrying it out? And what *is* Y, as an actual something-to-be-done?

The thinker summons recollection to his aid, collects all available data, tries to comprehend what is involved in each alternative. In a complicated case he may consult others, read books, undertake tentative experiments—anything or everything in order that the implications of the possibilities presented by the rival alternatives may be clearly ascertained.

Individuals exhibit great differences with respect to the synthetic power required for the comprehension of the implications of the alternatives in complex situations. We are likely to think that a good grasp of the situation depends upon the possession or acquisition of information. But it depends perhaps in greater degree upon the power to synthesize the facts that are available, and to understand them in their mutual implications. At no point in practical life does superior intelligence reveal its potency more effectively. The ability to "size up" or "take in" a situation is not a mere process of observing facts: it is a process in which facts are put in order, understood in their bearings and issues. In the presence of a multiplicity of information the dullard remains scatter-brained and irresolute.

The Evaluation of Alternatives.—When once the alternatives are fairly well known, they may be compared as to *the results to which they lead.* Alternative X leads to results *abcd,* and alternative Y leads to results *mnop.* Now *abcd,* as a result is, upon reflection, found to have the value of V-20, *while mnop* seems to have the value V-14. The *consequences* of the one alternative appeal to the person making the decision above those of the other. This "hedonic calculus" is, of course, only figurative, since values are hardly susceptible of quantitative representation (and we must be careful to avoid the implication of the hedonists that value reduces exclusively to terms of pleasure-pain). But it remains true that in the volitional situation the person deciding does represent to himself the outcome of his proposed acts as clearly as possible, and does consider the values or satisfactions that might result from the adoption of one alternative or the other.

Thus if a person be making a choice between a radio outfit and a trip to New York (we will assume that these are genuine alternatives), it is inevitable that he should consider the results to be gained by the one course or the other and the values to be yielded by each. He projects himself towards the future and tastes its values in anticipation. This process is one which strongly enlists the feeling life and introduces emotional factors into the situation—if it be a normal human situation. It is quite impossible to find a volitional situation which is not highly colored by affective tone. "A closer investigation of the volitional process as to its subjective and objective characteristics shows, however," says Wundt, "that it is most clearly connected with the emotions, and that it is really to be considered an affective process. There is no act of volition in which feelings of greater or less intensity, which combine into an affective process, are not present."

The Weighing of the Alternatives.—So far we have seen how in the volitional situation the alternatives are presented and analyzed. Let us assume that the thinker now has the situation before him as clearly as the occasion demands. But now there must be a final balancing of the books, the rendering of a decision. We must not pretend that the volitional process followed in regular routine the steps which we have outlined. On the contrary, most of our decisions follow an irregular and desultory course. William James, in his "five types of decision" has given us an excellent account of various ways in which, under differing circumstances, our volitional processes are terminated by decision. We may, for the sake of convenience, name the five types (James did not name them): (1) the reasonable, (2) the accidental, (3) the impulsive, (4) the revaluative, (5) the forced.

The *reasonable* decision is, of course, the ideal. "It is that of those cases in which the arguments for and against a given course seem gradually and almost inevitably to settle themselves in the mind and to end by leaving a clear balance in favor of one alternative, which alternative we then adopt without effort or constraint." Thinkers who are loyal to intellectual ideals will hold that, in cases where such a final balance is not forthcoming, the evidence is not all in. They would advise a continued scrutiny of the facts and possibilities. But, taking life as it comes, we may feel privileged to be able to make a decision of the reasonable type even occasionally. Usually we are too hurried.

Accidental decisions are usually premature from the standpoint of the ideal presented above. In the *second type* our feeling is to a great extent that of letting ourselves drift with a certain indifferent acquiescence in a direction accidentally determined *from without,* with the conviction that, after all, we might as well stand by this course as by the other, and that things are in any event sure to turn out sufficiently right. Some accidental external circumstance, some turn of events that makes one course momentarily more convenient or satisfactory than the other, decides the issue, and starts us into action. This type of decision, we may remark, is likely to emerge at the second stage of the general process which we have been surveying, where the implications of the alternatives as action-possibilities are under consideration.

The *impulsive* decision is similar to the accidental. But here the deciding push comes from *within* rather than from without. "It often happens, when the absence of imperative principles is perplexing and suspense is distracting, that we find ourselves acting, as it were, automatically, and as if by the spontaneous discharge of our nerves, in the direction of one of the horns of the dilemma."

Any such impulse is likely to be of the strongly emotional variety. A decision so arrived at is, of course, incomplete in the sense that the evidence is not all in. It is likely to emerge at the third stage of the volitional process as described above, where values, with their emotional concomitants, are being considered. Or, again, an impulsive action may be a mere explosion into action resultant upon the "intolerable pent-up state" that plagues us in our state of indecision.

The fourth form of decision, which we have called the *revaluative,* involves an entire shift of mental perspective. "It comes when, in consequence of some outer experience or some inexplicable inward change, *we suddenly pass from the easy and careless to the sober and strenuous mood,* or possibly the other way. The whole scale of our motives and impulses then undergoes a change like that which a change of the observer's level produces on a view. . . . All those 'changes of heart,' 'awakenings of conscience,' etc., which make new men of so many of us may be classed under this head." Thus a person who is hesitating between spending his money for a new automobile or putting it in the bank may find his decision suddenly terminated by a change of perspective—usually induced by some event—which shifts his whole scale of values. Such occurrences, in inconspicuous forms, are not unusual.

The *forced* decision is not necessarily, like the more impulsive or emotional form, incomplete as to the evidence, for the evidence may or may not be established. "But in either case we feel, in deciding, as if we ourselves, by our own wilful act inclined the beam; in the former case by adding our living effort to the weight of the logical reason which, taken alone, seems powerless to make the act discharge; in the latter by a kind of contribution of something instead of a reason that does a reason's work. The slow dead heave of the will that is felt in these instances makes a class of them altogether different, subjectively, from all the four preceding classes." Here the individual forces himself to make a decision by an inner *fiat,* a subjective impulsion. It usually occurs, as James observes, when the alternatives are equally attractive (or repellent) and when the choice to be made involves some sacrifice of the agreeable or some selection of the disagreeable.

Decision a Conflict of Impulses.—The volitional situation, while it remains in indecision, is attended by a state of stress and strain, of "pent-up feeling," which is usually interpreted as a conflict of rival determining tendencies.

Our analysis of the volitional process has so far taken into account only such tendencies as are consciously present. Had we dwelt longer, however, upon the way in which the possible *values* of our several alternatives are thought of, we might have observed that these seem to be based upon something enduring and basic in our natures, coloring the objectives rather than being colored by them. Our preferences, prejudices, likes and dislikes, are certainly never to be accounted for by the objective situation in itself, or by any conception of it that may be the product of momentary thought. Our determining tendencies, carrying with them our senses of value, are expressions of *character,* of the whole nature of the individual. The "sub-conscious" plays an important rôle in the making of decisions, if by the sub-conscious we mean the whole system of habits, embodied purposes, acquired preferences which enter into the formation of the individual's personality. Thus character —in the sense indicated—affects each and every judgment or choice. It is, if we may employ such a metaphor, the very balance upon which our alternatives are weighed and by which we determine their value.

We mean by *character* something relatively stable and permanent. The term denotes preferences in the way of action, established inclinations and ambitions, achieved standards of value. Character is a matter of habitual inclinations—but it is something more than *mere* habit. It involves the integration of the many specific determining tendencies of the individual into a single organic and dynamic whole.

"We are, then," says Ribot, "completely in accord with those who deny that the predominance of one motive is sufficient to explain volition. The preponderating motive is but a part of the cause, and always the least, although the most visible; and it has efficacy only in so far as it is chosen, that is to say, as it enters as an integral part into the sum of states which constitute the ego at a given moment, and as its tendency to act is added to that group of tendencies which spring from the character, to be consolidated with them. It is then in no wise necessary to make of the ego an entity, or to place it in a transcendental region in order to recognize in it a true causality. It is a fact of experience, very simple, very clear; the contrary is not comprehensible.

"Physiologically, this signifies that the voluntary act differs both from the simple reflex, where a single impression is followed by a single contraction, and from more complex forms, where a single impression is followed by a number of contractions; that it is the result of the entire nervous organization, which itself reflects the nature of the whole organism and reacts in consequence. Psychologically, it signifies that the voluntary act, in its complete form, is not the simple transformation of a state of consciousness into movement, but that it supposes the participation of the whole group of conscious or sub-conscious states which constitute the ego at a given moment.'' While, therefore, Will involves in some sense a clash of conflicting tendencies, we must avoid the once stereotyped opinion that Will can be explained as a mere struggle between conflicting impulses.

Determining Tendencies.—The character thus constituted is dynamic, and its elements are motives, or tendencies to preferred lines of action. These tendencies, in the case of any human individual, are innumerable, representing all of man's diverse needs, desires, and aspirations. In any volitional situation the *decision,* the final balancing of opposing forces, is achieved by the state of potential or balance existing in the total system of tendencies that makes up the something we call character.

It is a familiar fact that if a person be undertaking a certain task he is ''set'' for that performance. Any such set may be called a determining tendency. Thus if one be prepared to play tennis the organism is tuned accordingly. All of the sensori-motor coördinations, all of the perceptual patterns which function in tennis-play are active, whereas other reaction modes, adapted to other circumstances, are inhibited and momentarily passive. Once a ''set'' of this kind is taken it requires strong incitement to induce a shift to another. One who is set to play the game—even in anticipation—surrenders his intention with reluctance. But a strong shock in the midst of a game may succeed in bringing another determining tendency strongly into the foreground. Word that wheat has dropped a half-point on the market may transform the player from tennis enthusiast to anxious wheat merchant in a moment. The attitudes are wholly unlike, in what they directly involve in the way of action, preference, memory, perception.

Certain of these determining tendencies are stronger than others in the sense of being more inclusive and thus involving more extensive motor and perceptual systems. Some are better established and confirmed by practice. In the typical volitional experience some of these more extensive reaction systems are sure to be involved. These stand out prominently, so that we are likely to describe our effort at decision as a struggle between such systems.

Effective Conceptions.—William James, in discussing the *reasonable* type of decision, explained above, makes this comment: "The conclusive reason for the decision in these cases is the discovery that we can refer the case to a *class* upon which we are accustomed to act unhesitatingly in a certain stereotyped way. . . . The moment we hit upon a conception which lets us apply some principle of action which is a fixed and stable part of our Ego, our state of doubt is at an end. Persons of authority, who have to make many decisions in the day, carry with them a set of heads of classification, each bearing its volitional consequence, and under these they seek as far as possible to range each new emergency as it occurs. It is where the emergency belongs to a species without precedent, to which consequently no cut-and-dried maxim will apply, that we feel most at a loss, and are distressed at the indeterminateness of our task."

This is another way of saying what has been explained above that in analyzing and representing a situation to ourselves we are influenced by certain determining tendencies. These we think and speak of as principles of action. Such principles of action are not so many bolts from heaven. They are what we accept, for the time being, as so many ideal principles of behavior; they are patterns that we have acquired in the course of our reactions to actual situations. Hence principles of action vary for individuals and for groups.

We have spoken of principles as ideal patterns of behavior and of their conjunction with our conception of a situation. But principles in any ideal sense may be absent or inoperative and our conventionalities may stand in their stead. We develop conventionalities, for instance, of a political sort and of a religious sort and of many other varieties. Because we have grown up in a community in which the majority of the people are Republicans or Democrats—in which those whom we most admire and who are closest to us socially, at any rate, belong to one or other of these parties—we drift into a corresponding affiliation as a matter of course; and as a matter of course this affiliation has our approval; it seems to us that this connection carries a real value that other political connections do not carry. We have never thought the matter out and we could give no substantial reason for our political party preference. We have merely drifted in this direction and that is the end of it. We are satisfied and we flatter ourselves when we say that we have "convictions" or "principles." In like manner we develop conventionalities in the sphere of religion; in our moral, professional and commercial and recreational life. They are effective in determining our decisions when alternative courses of conduct are before us just as principles of conduct are. If a dyed-in-the-wool Republican can once see an alternative course of political action through his eyes *as a Republican* that course of action will be his. So much, then, for the volitional process and the manner in which decision is accomplished.

The Initiation of Action.—But once this preparation has been completed there still remain two major problems in connection with voluntary action. First, how do the actions—movements—get started; and secondly, how are they controlled once they are under way?

We can make a useful descriptive contribution to the problems. The state of attention itself directed toward the contemplated action and the purpose it is expected to serve is, from one angle at least, a state of bodily preparation for the act. Observe the runner when he is attentively awaiting the signal to go. Every muscle is tensed up and ready for the initial movements that the race requires. In the baseball game the state of attention of the man at the bat is, from one point of view, a bodily readiness to strike. The student in geometry, attentive to a problem, is in a state of bodily readiness to take his drawing instruments and to produce a figure by the aid of which to solve a problem. But undoubtedly this bodily readiness is not merely one of the external, coarser muscles. It is through and through. The subject is on a hair trigger; balanced on a knife edge, as it were, so that the very slightest stimulus that is related to the situation will set him off. Thus when the runner is attentive and tensely awaiting the crack of the pistol that is the prearranged stimulus to set him off, the cracking of a twig may put him on the go or, for the matter of that, he may go upon an imaginary signal.

But he could not go at all if he had not previously had experiences of a nature similar to running. The kinæsthetic sensations or sensation of movement incident to running must already have been familiar experiences. This is the implication in the saying that before one can perform a voluntary movement one must already have a background of kinæsthetic sensation.

One of the best demonstrations of the function of kinæsthetic sensation in relation to voluntary movement is to be found in the process of treatment of certain apparent paralyses. A child, for example, has never moved his right arm, notwithstanding that examination shows that his muscles and their nerve connections are all intact, even though the muscles may be flabby from disuse. In such a case the physician sets about it to build up a background of kinæsthetic sensations associated with the defective arm and he accomplishes his purpose in the following manner: he takes hold of the so-called paralyzed arm and causes it to move upon the shoulder joint—first a little and more and more in successive experiments—the while bringing the patient's visual attention to the moving arm and asking him at the same time to notice how it feels. After some experience of this sort he can without aid move his arm upon the shoulder. By the same process of training he is enabled to move the forearm upon the elbow and successively his wrist and finger joints are brought into use.

It is probable that in a case of this sort the patient began life with an actual lesion by reason of which he could not move his arm after the manner of young children who normally activate all their muscles spontaneously. By so doing they build up a kinæsthetic sensation complex of enormous complication in association with every muscle in their organism. These sensations are what Professor James called the "resident cues" that function in relation to the launching of voluntary actions.

These cues are of service to a subject when, for example, he for the first time in his life sits at a piano and attempts to manipulate the keys. He is able to make the effort only because he has theretofore on possibly countless occasions made similar movements spontaneously or otherwise. He is familiar with the kinæsthetic sensations that must arise from fingering the keys; he can command at least a vague imagery of them in advance of his touching the keyboard. We say he imagines the feel of playing at the piano and rightly we urge that this imagining is a mental trial-and-error by dint of which he facilitates progress.

The Control of Action.—In the next place there is the problem of controlling action, once it has got started. For the purpose of such control one has to rely again upon attention and sensation. How does one continue upon a course once it has been chosen and once action has been initiated? Concretely, how does one continue riding a bicycle or walking in the street when at last one has got started on the way?

One can obtain a clue to the answer to this question if one will consider the familiar inconvenience of the sleeping foot. In such a case one is not able to walk with normal ease and grace, and the inability is due very largely, at any rate, to the fact that the normal sensory impulses from the feet and the corresponding sensations are lacking. The nerve trunks on the posterior aspect of the knee have been compressed sufficiently to interfere for the time with the passage of sensory impulses from the foot to the central nervous system. A corresponding result may be obtained by anæsthetizing the soles of the feet so that the sensory impulses that normally arise from pressure of the feet upon the ground are lacking. An analogous situation occurs when one is riding upon a bicycle. So long as the experienced rider's feet are squarely upon the pedals and he is firmly upon the seat, the normal flow of afferent impulses continues in orderly succession and riding is a matter of course; the whole delicate process goes on without a hitch. But let a disturbance of the sensory experience occur—if it arises only from slipping a foot from the pedal—and the rider's control will waver, if for but a moment.

How shall we conceive of control in these cases? Allusion has already been made to bodily adjustment as a feature of the state of attention. Attending to the purpose of the bicycle ride or to the end that is to be achieved by it carries along with it an adjustment of the body as a whole—a preparation, as we have already put it, for riding the wheel. Now come the sensory impressions from the feet and the body in contact with the machine—troops of them in single file or many abreast—and, in the learner at any rate, each of them comes into attention and induces a conscious adjustment; a tension of appropriate sets of muscles; that is, a readiness to react. In the course of time and practice the higher brain areas are short circuited and consciousness goes by the board, but the sensory impressions are still there and they continue to introduce the ministry of preparatory adjustment each one in its turn and each one—so long as everything goes well—periodically repeating its earlier performance. But let the foot slip the pedal or let the wheel skid beneath the rider: immediately there is a new pattern of sensory impressions, new adjustments are thereby introduced and consciousness *in relation to the movement of riding,* that has been *in obscuro* for some time, becomes clear. Control of the voluntary process of riding is endangered, to say the least, and it may be lost. The issue depends upon whether the unusual sensory impressions can with speed and accuracy make the circuit to the appropriate muscle systems so that balance may be recovered.

The act of walking, of typewriting, knitting, of sending and receiving telegraphic messages and any one of a hundred other activities afford other excellent illustrations of the operation of the factors in control that we have been describing.

It may place a tension upon the imagination of the beginner in these studies, and of the layman—this urging the adequacy of sense impressions to initiate the millions on millions of muscular adjustments that inevitably occur in the course of a half day's ride upon a bicycle. But let the reader recall what was emphasized in the chapter on Sensation; the enormous capacity of the organism through its sense organs to discriminate small differences in light, shade and color; in weight, movement, odor, taste and touch, to make but a partial enumeration. Each of those thousands of discriminations is itself a motor adjustment and the combination of such adjustments is legion.

In our discussion of control to this point we have had before us the function of sensory impressions that arise in a member of the body that is in direct contact with the machine—the foot, for instance. Remote sense organs are effective, too. When the rider *sees* the stone in the road he makes an avoiding reaction and misses it. When he sees the smooth path he heads for it. When he *hears* the claxon behind him he dodges to the right. When he *feels* himself incipiently falling toward the left he forthwith turns his wheel in that direction; and for the experienced rider there is a forthrightness about all these reactions that suggests that the remoter sensations we have referred to are, each in its own sphere of action, quite as directly as any other, holding the reins of control of our volitional actions.

We have now discussed the preparation for volitional action, its initiation and its control. Preparation consists in arriving at a conception of the essential nature of whatever alternative courses of action there may be in making a decision. The initiation of an act implies the function of a background of kinæsthetic sensation and of a kinæsthetic imagery of a contemplated action. Without these functions movement is impossible—unless it be of reflex or allied form. The control of an act, once launched, implies the functioning of attention to the goal and to intermediary adjustments—because attention from one angle is a bodily preparation—and at the same time the functioning especially of sensory impressions of movements that are incident to attaining to the purpose of the act.

The Nature of Will.—Voluntary actions are willed actions; and they have been taken as indicators of the existence of a *will;* and will is a term to bandy about. It has been a distinct faculty or department of mind with boundaries all its own enclosing it in a tight compartment. It has been a specific function; a specific piece of machinery with particular things to do; it has been the activity of attention; a peculiar force driving the organism. But there is no good evidence in introspection or otherwhere for any of these conceptions. We prefer to mean by the term an ensemble of impulses; or better, the energy of the organism that is released in the sensory impulse, in perception, in conceptional thought, in attention and released by our contacts of every sort with our changing surroundings. It is energy directed and controlled by attention, sensation, purposes and ideals indirectly through their motor accompaniments and directly by the habits and dispositions, native or acquired, that are a part of our total reaction system. This is the meaning of those who describe will as "the whole man active" or as the "sum total of all our impulses toward activity."

It is customary to associate effort with willed actions—and it *is* there because it always goes along with attention of the voluntary kind; and the consensus of opinion is that this effort in its turn is the sum total of the organic and kinæsthetic sensations and the like that arise from all the partial and trial adjustments that accompany these forms of behavior, particularly in the preparatory stage.

The Strong Will.—It will now be apparent what is to be understood by the popular phrase "a strong will." It has no necessary moral connotation whatever in the everyday sense of the word. An individual sets about an involved problem and fights it out against difficulties to a successful completion and we say he has a strong will. In other words, he came at the outset to a distinct conception of what his problem is. Let it be that it is to "put over" a policy of universal conscription of the able-bodied men of the United States at the outset of an international war. This he must conceive as an interference of first magnitude with that liberty and freedom of action that is the inalienable right of every citizen of the Republic. It is a policy that is all but directly counter to the traditions of the land and of the sister nation from which, in the main, we have derived our political and social life. Furthermore it is a policy that, in a population of conglomerate national origins, will inevitably cut across many a sentimental tie to more than one fatherland. These situations the promoter must envisage distinctly and he must face them frankly. On the other hand, this strong-willed leader *conceives* the common interest that bridges the gaps between groups of different ancestry and while not denying the right to freedom of action on the part of every citizen he conceives of the out-and-out voluntary system of recruiting as an implied playing of favorites where common interest is at stake. At least it can be so interpreted, and probably will be ultimately, if not now. In the end, therefore, he conceives of universal conscription as the method of raising an army that is most consistent with democratic ideals in the long run. Having reached this point there is no dallying with pro's and con's. He is ready to plunge into the practical problem of devising ways and means. His conception of common interest in spite of divergent sentimental ties gives him his cue. The ties of sentiment are real obstructions and they must be reckoned with. A proclamation issued point blank will fail. He decides to address himself to driving home the idea of common interest. An educational campaign is set on foot accordingly and in prosecuting it he summons to his aid all the imagery that he can command, grounded upon his own experience and upon that of others who are associated with him. He plans the game in the realm of ideals and so refines his method in advance.

Because he himself, perchance, is an educator of experience, he can take the field and be one of many who will begin the more distinctly motor functions of his office and control his activity until at last the goal is reached.

The foregoing will serve to illustrate the strong-willed individual in a sphere of action that is less motor than ideal. He sees what is involved in a situation. He appreciates its weight. He looks ahead and adapts means, unflinchingly, to ends.

In the more clearly motor sphere of voluntary action consider the driver of a motor truck who is forcing his car against time over a five-hundred mile difficult road through the mountains. He has hitherto felt the throb of his car over thousands of miles of road and his ear never misses the audible signs from his motor. By touch and by ear and in other ways he is thoroughly acquainted with his machine. The *feel* of it and its sound are signs that are unfailingly followed by his depressing or releasing the accelerator; applying or letting up on the brake; turning the steering gear quickly or slowly to right or left; retarding or advancing the spark; opening or closing the muffler, etc., each of which adjustments is made without thought of the performance and instantly upon receipt of the appropriate resident or remote cue.

We say this is a man of strong will, and we are justified in saying so not only because he undertakes this difficult and dangerous job, but because he has an acquired set of motor reactions or habits that do not fail him even in the midst of emergencies: that enable him to do the right thing at the right time and that bring him to the end of his journey—let us say—ready to do it again. For indeed the stronger of will he is, in our sense, the less will he suffer from fatigue in the course of our hypothetical journey.

One thing more we should say to characterize our strong-willed individual, whether he is working more especially in the field of ideas or in that of motor performance. He has a vivid emotional reaction to his work and a vigorous feeling of purpose. It is at the time the worth-while thing to be doing. It enlists his enthusiasm. But after all, this goes without saying. When there is no such emotional reaction the human organism is at least sufficiently out of joint to make it wholly impossible for willed action to be done faithfully and decisively. Indeed, in an extreme emotionless state it is impossible even that they be undertaken or carried on at all.

The Weak Will.—If our concept of strength of will is correct, then clearly its weakness is the reverse of the picture. There is an attitude of scattered attention; of purposelessness; of low level of enthusiasm and of illy-knitted habit structures. Any one of the first three of these will make a weak will along the whole front; and if an individual is weak in any one of these respects, it is impossible for him to lift to a high degree of perfection any specific habit. It requires the qualities of purposiveness and of enthusiasm to develop to a high degree even the motor habits of a typist.

Everyone is familiar with the "good" boy and the "good" man who lacks these qualities. He faithfully obeys when others take the initiative. But "others" there must be. He is a lump of soft putty without resiliency. Yet capacities for independent action there may be; but it requires an extraordinarily strong stimulus to bring them into activity. This will suggest the youth who habitually spent his time in his father's arm chair lazily browsing among the books and occasionally playing a game of chess but who never took the initiative in pranks and games with his fellows in any relation whatever. When, however, the local chess team was about to play a match with a team from the next town and was in sore need of filling a temporary gap in their ranks, he stepped in at their invitation and played his part with fair credit, he understood that he could take a hand with others and was appreciated on that account. He took a new grip upon his life, resolved to take his place in extra-chess-game relations, and forged ahead independently into a profession and to the front rank therein. Such was apparently the effect of a purpose that was aroused by a seemingly trivial incident but one that nevertheless supplied a vigorous motive; a motive that in his case, through the fortunate intervention of others, was maintained at white heat throughout a critical period. Had it not been for this intervention he might have lapsed again into his former state of ineptitude.

The foregoing observation makes it pertinent to recall the case of a young soldier who had been taken in the draft in the World War. Previous to his induction into the service he had spent his days upon the porch in harmless inactivity, leading a life of mediocrity wholly aloof from the vigorous life that was surging among the neighbors of his own age. On the battle front he was caught in a critical situation. His regiment had gone forward and later retired, leaving him and seven companions in a shell hole, surrounded by the enemy. He took charge of the situation and stood off the enemy. Two of his companions were killed and three were wounded. He dressed their wounds, bucked up the party and continued holding his opponents at bay two days till he and the survivors were rescued by their own regiment in the course of a second advance. Today this young man wears a Congressional Medal for distinguished and meritorious service, but he occupies the front porch as formerly because there is no extraordinary persisting stimulus and no stirring situation that is adequate to keep a none too vigorous purpose and enthusiasm alive. Obviously one of the prime functions of parents and educators is to supply the conditions that will awaken steady purposes and lead on from one purpose to another and from one victory to another.

Aboulia.—In extreme instances weakness of will is pathological and the condition is known as aboulia. Apart from whatever physical deterioration may exist—and there may be none—the condition is marked by a listless emotional state; inability to reach a decision or to initiate any voluntary reaction whatever. The patient must be pushed into even the behavior of dressing for breakfast. Therapeutic treatment in these cases is a problem of applied psychology. It presents extraordinary difficulties and demands the service of an experimenter who will patiently fish for the slightest indications of interest in any one among many situations; and having found the least evidence of the sort to feed that interest by every means in his power and to incite whatever motor reactions may be possible in consonance therewith until they are established as habits. All along the line he must applaud each successful reaction—even though it be microscopically successful—and also, along the way he must look with an eagle eye for the minutest evidence of related interests and feed them as they occur.

The study of willed actions thus brings us back to a study of the organization of the personality. Volition, will, impulse, are active correlates of forms of thought and perception. The subject matter of our earlier chapters and of this one are mutually supplementary. There are no new factors here and no specific formulae.

The Training of the Will.—It is now clear—what should be our point of departure in a discussion of the development of will power or the training of the will. Every professional psychologist is now and again asked to supply a method whereby the inquirer may strengthen his will. But there is no royal road to that end and there is no specific formula. Forcing oneself to an early rising and compelling oneself to run six times around the barn before breakfast or to do some other useless and difficult thing daily will not bring the result sought for. But if a youngster, from the time he begins to toddle, is encouraged to lead a life of physical and mental activity in play and work covering a wide range of contacts; he will, assuming a condition of health, develop that background of kinaesthetic and other imagery that plays so large a part in the preparation for action and in its initiation and control. He will become thoroughly acquainted with himself; he will know his own capacities and limitations and thence will arise a sense of confidence in himself and enthusiasm for work and play. And the adult, for that matter, may, in some measure, at least, make good the shortcomings of youth in this regard if he will go about it to establish the habit of undivided attention to his work; energize himself to do with a bang whatever comes to hand, and if he will at the same time be critical of his own product, the most effective possible training of will may be assured; for out of it will come those motor habits which in part are the attitude of attention and of holding that attitude till the work is finished. Other more specific motor habits of hand and foot will develop and all together will facilitate doing the work of the day and the unusual task with dispatch and accuracy: and this is the only kind of a well developed strong will that is in the least worth having.

It will be obvious that no one can be strong in this respect *along the whole front* for the simple reason that no one can have strongly developed habitual attitudes of attention to more than a few of the social functions of men and women in modern life. Nor can we have developed all the specific motor habits that play a part in the life even of a small community. It is impossible that a lifetime editor of a metropolitan daily should have developed the motor habits of a blacksmith or even that he should experience the purposes, specifically, of a blacksmith. Rather than talk about *will,* then, we should speak of *wills.*

CHAPTER XIV

APPLIED PSYCHOLOGY

> ''Art in general consists of the truths of science arranged in the most convenient order for practice instead of the order which is the most convenient for thought.''
>
> —J. S. Mill

Psychology may properly be asked whether it can justify itself in a practical way: that is, whether it can contribute to an understanding of the human factors that enter into an everyday situation; whether it can tell what degree of intelligence is requisite in the situation; what special degree of abilities it requires; whether it can point out the individuals who are fitted by reason of intelligence for particular forms of coöperation with others in the day's work; whether it can point out the stimuli, or better the situations, that are suitable to induce coöperation amongst the members of a group and whether it can bring it to pass upon a desirable plane. These queries are at the bottom of the movement for intelligence testing, and of applied psychology in all of its ramifications.

Psychology is asked what it can say of the personal qualities—aside from intelligence—that are necessary for adjustment in particular relations. Its reaction to this question is its attempt at describing and rating the non-intellectual characters of men and women; and this represents a large part of the work of the personnel offices that are coming into vogue in colleges and universities and that have longer had hold in industrial and commercial organizations.

The science of psychology is being required to make some contribution toward understanding and preventing the planting and growth of those personality traits that interfere with one's coöperation with others in practical ways and toward uprooting them and preventing their development, once they are found reaching out for a place in the sun. Finally the psychologist is being required to contribute toward the solution of many problems relating to the handicapped; such e.g., as are involved in the development of a substitution of one function for another as touch for vision in the case of the blind, who are learning to read by tactile impressions; of touch for hearing in the deaf who, in current experiments, are learning to understand speech by way of vocal vibrations communicated to the tactile organs; of touch or vision as a substitute for hearing in the mute who are finding in one or the other or both a criterion for vocal control. Similarly, when one set of muscles has been made to do the work of another that has become unable to functionate we are confronted with a situation in which one group of kinæsthetic or motor sensations has been made to substitute for another that has been lost. The obligation is upon the psychologist to apply his science to the end that all these substitutions and many others may be brought into being. Psychologists have felt this obligation more or less persistently as long as men have been studying human behavior and attempts at meeting them have resulted in the development of psychiatry, of the principles of mental hygiene and even of ethics.

No one of these problems is completely distinct from the others. This for several reasons: intelligence is not a thing, nor even a specific function. It is a coördination and coöperation of many functions that normally lead all together to a satisfactory adjustment of the individual to his world. When we talk of intelligence we are emphasizing the function of memory, of conception, of reasoning and the like. Some or all of these functions may be retarded as to their operation by one personality trait and may be accelerated by another. And even these traits are sharply distinct from intelligence. Again it is a matter of emphasis, for when we talk of personality traits we are emphasizing emotional trends, sets or attitudes; or habits in a broad sense of the word. Successful mental hygiene waits upon at least a fair degree of intelligence in the sense of an insight into one's own condition and of foresight of what may be gained by following a mental health regime; and the functioning of intelligence, even in its most restricted sense, waits in turn upon favorable emotional trends and habits; personality traits in short. The successful substitution of one function for another, likewise, waits upon intelligence in the broader sense in which the term has come to be employed.

Aim of Applied Psychology.—"Efficiency" has become the watchword of "practical" or "applied" psychologists, because it is their aim (as commonly understood, at any rate) to determine in advance what is an individual's capacity for adjustment. This to the end that he may be placed in school or in occupation where he may accomplish most, and to remove or allay personality obstructions that stand in the way of such accomplishment.

It ought to be said in this connection, however, that this is only the proximate aim of applied psychology; for the theory is that by placing a subject with due regard to his capacities and weaknesses, we secure his greatest happiness, and more than that, his greatest opportunity for the realization of his needs—physical, intellectual, social, moral, æsthetic and religious. The opposition of labor to the policy of students of applied psychology on the ground that it operates against the uniform treatment of all employees is short-sighted. Men are not all built upon the same pattern; they cannot all do the same work equally well; and therefore their own self-interest and that of the community they serve cannot be guaranteed unless we know the utmost of their nature in advance and aid them by all means in our power to place themselves with regard to their nature.

Industrial interests will encourage the program of applied psychology for the same reason that leads them to encourage temperance and peace; because it makes for efficiency and consequently for production. But the economic issue is not the great one involved in either temperance or peace. It is only the immediate pressing issue. So efficiency is the most *conspicuous* principle in applied psychology, but that of self-realization *in its fullest sense* is its real objective, assuming always the understanding that no man ''liveth unto himself alone'': that each one must both sacrifice and gain in adjusting himself to persons as well as to rocks and trees and storm; all toward the great end that men may live together satisfactorily.

Intelligence Testing.—Some of the most fundamental problems of the student who attempts to find uses for psychologic method in the work of the day are to devise intelligence tests, to apply them and to interpret the results.

It would be futile to attempt a sharp definition of intelligence. We have already spoken of it as a coördination and coöperation of many functions. Few, if any other psychologic concepts are bandied about more freely. Repeatedly, in every walk of life, we are describing men and women in terms of high, low or average intelligence. The term does not carry the same meaning to the man in the street as to the specialized student of human nature. To the former it appears to mean, when it is asserted of an individual, that he possesses a large fund of information and perhaps that he talks and writes freely and convincingly. But to the other the term connotes, not only the possession of information but the capacity to gain more and to put it to work *effectively* in vocal expression and otherwise. It implies a capacity for adaptation of the individual to the circumstances in which he is placed. Accomplishment, therefore, is the most patent criterion of intelligence, and this is an undubitable sign of a capacity to adapt one's self to the circumstances one has had to meet; not necessarily to all circumstances that are possible even in a given vocation.

This may be far from an intellectual quality in the academic sense: that is an ability to analyze a more or less involved situation: to see clearly what is implicit in it and no more than that. This ability implies intelligence, or adaptability, in an important sense, to be sure. But there are other varieties. It is evidence of intelligence also, that one is able to take the results of the analyst's labors and, putting them to use, to adapt means to the ends of building bridges, managing department stores, being a good citizen, etc. Mental alertness, or sensitivity and activity, is at the foundation of every form of intelligence. The superstructure varies with the individual's tastes, acquired and native dispositions or prejudices, psychoses, etc., all of which may be subsumed under the general title, "personality traits."

Various modes of testing * have been developed for the purpose of meeting the needs of those psychologists who have undertaken to determine in advance the adaptability of individuals to school and industry and to uncover the reasons for maladaption in these relations.

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* (The term *measuring* is sometimes used instead of *testing*. There is no sharp distinction between them. The former has come to be used more especially in relation to laboratory work, where one individual is taken at a time for intensive examination under strictly controlled conditions, and where mechanical appliances are employed to obtain the utmost possible accuracy of result. The term testing, on the other hand, has come to be applied to working simultaneously upon all members of a group obtaining their reactions in writing or other form of action to a set of questions or directions and later giving these reactions a statistical treatment. Testing, therefore, yields in short space a mass result that contains more or less important information concerning the group as a whole. It singles out a few at the bottom and a few at the top of the scale and it has come to be regarded as good practice to hold over these few at each extreme for *measurement*.)

The Binet-Simon Tests.—The Binet-Simon Tests are the original and best-known of what are described as *mental age* or *general intelligence* or *mental alertness* or *mentality* tests. They are built upon the assumption that it is possible to arrange a graduated series of reactions that can be performed by normal persons of different chronological ages respectively; a reaction, that is, that can be done by the seven-year-old but not by the six-year-old; by the eight-year-old but not by the seven-year-old, etc. As a matter of fact in building up the tests a group of four or five reactions were selected for each chronological year-age up to early adolescence. Selection of details for the seven-year-old tests, e.g., was made after careful observation of normal children of this age to discover what they, on the whole, could do, but that were not possible, on the whole, for six-year-olds.

Those whose chronological age is six but who can handle the seven-year-old tests are called "mentally seven years old." They are one year advanced. Conversely, if they can do no more than the five-year-old tests they are "mentally five years old" or one year retarded. The results often indicate fractional years of advancement or retardation. Advancement came to be interpreted as an indication of precocity and retardation of dullness. A retardation of as much as three years, in the earlier period of examination by this method, came to be regarded as evidence of feebleness of mind; and this was defined as a natural condition of defect, or arrested development—dating from birth or very early age—by reason of which the victim could not take care of himself or of his affairs with normal prudence.

These interpretations were rather uncritically accepted popularly, and by many students of psychology, in the earliest years of testing following 1900. What "normal prudence" is, for example, is impossible to define. Each one of us would be inclined to define it in terms of his own behavior! Furthermore, if we could agree that Mr. A. is managing his office in this community with "normal prudence" we might find that he is not capable of directing a similar office in another neighborhood where the community ideals are upon a higher plane and where the human elements are very different from those to which he has become accustomed. Inevitably qualifying factors came into observation. There is less disparity, for instance, amongst individuals whose chronological age is five years than amongst others who are chronologically seven years of age; and considerably less amongst seven-year-olds than amongst those who are nine. And these differences become very striking when we observe a group of adolescents of fourteen or fifteen years of age and older. A year's retardation at one point in the age scale, therefore, may not mean what it does at another point. This fact presents an extraordinary obstruction to fairness in the expression of the mental age of widely different chronological ages. Suppose that one whose chronological age is twenty-four can do no more than meet the tests that have been devised for one whose chronological age is twelve. We say that his mental age is twelve. But this is a comparison of a man with a child; very different things. The man's interests, inclinations, habits must be assumed to have diverged very widely from those of the child and likewise his informational material. One and the same formula for the expression of intelligence level cannot with entire satisfaction be applied to both.

The most familiar method of stating the results of testing is in terms of Intelligence Quotient or I. Q. This is the quotient found by dividing the mental age by the chronological age. Thus the eight-year-old who can just answer the eight-year tests and no more has an I. Q. of 8/8 or 1. If he can answer the ten-year tests and no more his I. Q. is 10/8 or 1.25. If the most he can do is to answer the six-year tests the I. Q. is 6/8 or 0.75. These results are usually expressed without the decimal point as 100, 125 and 75, respectively. Terman has interpreted various ranges of I. Q.'s in terms of popular speech as follows:

Above 140, Near genius or genius.
120–140, Very superior intelligence.
110–120, Superior intelligence.
90–110, Normal or average intelligence.
80– 90, Dullness, rarely classified as feeble-mindedness.
70– 80, Border-Line deficiency, sometimes classifiable as dullness, often as feeble-minedness.

Performance Tests.—No revision of the Binet Tests has quite satisfied its critics that it reveals the real nature of one to whom it is applied. It demands a certain familiarity with a particular language for one thing, and whether one possesses such familiarity or not depends upon a variety of external circumstances and by no means wholly upon one's nature. To say the least, language is very largely a product of learning at school and at home. In similar terms one may speak of very many of the specific reactions that are sought in a subject when intelligence tests are given. For this reason it is very difficult to say to what extent one's rating is due to one's natural capacities—in which we are most interested—and to what extent to environment and to learning.

Consequently a great deal of effort has been expended in the direction of developing tests that will not require a facility in language on the part of one who is being examined and that can be taken without resort to the results of instruction in home or in school. This has resulted in what are known as performance or construction tests.

A simple example of this sort of test is the ''form board.'' It has been very useful in detecting those whose defect is so pronounced as to mark them feeble-minded. The material consists in various geometrical forms, such as stars, diamonds, squares, triangles, circles and the like, that have been cut out of a base board. The tester goes through the motions of placing each block into the form in the base board that has been prepared for it and into which it will fit exactly. When he has finished he displaces the blocks and beckons to the subject to replace them with all possible speed. The performance can be graded upon the basis of the total number of movements the subject has made—upon the number right and number wrong—and upon the time he has consumed. The test reveals defect in ability to understand instructions; to observe what is going on; to perceive the general and particular situation; to profit by experience, and to recognize form and size and other space relations.

It has been standardized by application to over 1500 normal children of various ages. The average time of performance for each age has been determined and the range or number of movements. By reference to these norms, therefore, it is easy to determine, in respect to behavior at the form board, whether a given individual is up to normal for his age and how far he surpasses or falls short of it.

Other tests of the performance variety involve such as the completion of a picture board, sections of which have been cut out and are lying at the hand of the subject; the opening of a puzzle box and the like. A definite minimum number of movements is required for such tests and the minimum time needed has already been approximately determined. Many tests of this nature there are and many are being standardized after the manner of the form board described above.

These tests and scales have been used chiefly for the purpose of educational diagnosis; to discover the degree of backwardness of children in the grades, their need for special attention, or the hopelessness of a given sort of pedagogical effort with them. But they are of some use as well to the employer of labor. There are some occupations such as delivery boy, messenger, domestic servant, nurse, elevator operator, driver, motor man, etc., into which the feeble-minded may easily slip, especially if they are checked only by casual observation. The tests may discover such persons and so spare the employer the disadvantage of an irresponsible would-be helper. But it is not good form to depend upon them entirely.

The Army Tests.—With our entrance into the World War in 1917 it became necessary at once to select, sort and assign millions of men in the most expeditious way consistent with the good of the service. The American Psychological Association was called upon for whatever aid it deemed itself capable of rendering in this gigantic operation. The result was the creation of the well-known system of army mental tests. There are two such systems; the Alpha, designed for literate recruits; that is for those who could read and write a letter, and the Beta tests, designed for illiterates.

The Alpha system was built upon the general plan of the Binet test. Its purposes were to aid: "(1) In the discovery of men whose superior intelligence suggests their consideration for advancement; (2) in the prompt selection and in the assignment to development battalions of men who are so inferior mentally that they are suited only for selected assignments; (3) in forming organizations of uniform mental strength where such uniformity is desired;

(4) in forming organizations of superior mental strength where such superiority is demanded by the nature of the work to be performed; (5) in selecting suitable men for various army duties or for special training in colleges or technical schools; (6) in the early formation of training groups within regiment or battery in order that each man may receive instruction and drill according to his ability to profit thereby; (7) in the early recognition of the mentally slow as contrasted with the stubborn or disobedient; (8) in the discovery of men whose low grade of intelligence renders them either a burden or a menace to the service.''

The Beta tests were built upon the plan of performance or construction tests. They were designed to require nothing in the way of language or other such social accomplishments as result from attendance at school. Directions for reacting to the tests were given both by word of mouth and by gesture.

The scores were translated into letter grades. The table below shows these grades with their interpretation in ordinary speech and their distribution or per cent of each grade on the basis of the total number examined:

Intelligence Rating	Interpretation	Distribution %
A	Very Superior	3.5
B	Superior	7.5
C+	High Average	13.5
C	Average	21.5
C—	Low Average	22.0
D	Inferior	22.0
D—	Very Inferior	10.0

The following figures illustrate graphically in two ways the distribution of intelligence in the army.

The second figure above demonstrates that levels of intelligence (letter grades) among recruits, as they were determined in this case, differ with the occupational groups to which the men belonged in civil life. It was possible, therefore, to predict fitness for given army work at the time of enlistment and for admission to the training school.

Tests of this sort are yet crude enough in spite of years of intensive labor upon them by many competent hands. They have been subject to much abuse by their incompetent friends. They have official recognition in many school systems and in institutions for the care of the mentally defective, the juvenile delinquent, the criminal, the physically handicapped, and of those who for any reason have proved themselves unable to keep step.

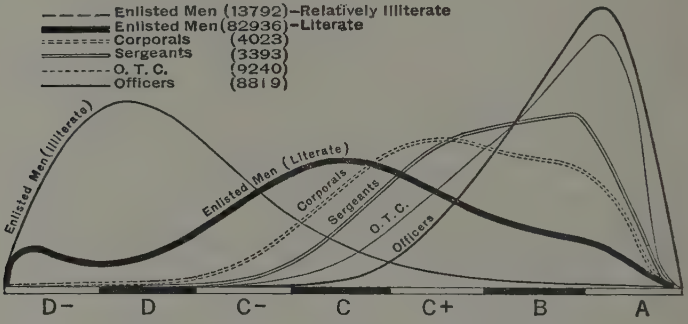

FIG. 41.—The distribution of intelligence ratings in typical army groups, showing the value of the tests in the identification of officer material. The illiterate group given Beta (a picture test); other groups Alpha.

The psychological ratings have proved valuable not so much because they make a better classification than would come about in the course of time through natural selection but chiefly because they greatly abbreviate this process by indicating immediately the groups in which suitable officer material will be found, and at the same time those men whose mental inferiority warrants their elimination from regular units in order to prevent the retardation of training. Speed counts in a war that costs fifty million dollars per day.[1]

[1] Seashore's Introduction to Psychology. Copyright 1923 by The Macmillan Company. Reprinted by permission.

Intelligence tests, such as those to which we have alluded, may be given either to groups at one time or to individuals singly. Ordinarily (with the exception of certain performance tests) they are given to groups and the results are then treated statistically. In such a case, obviously, individual differences are lost sight of in the averages and the tester knows only that the group as a whole, compares thus or so with another group. He has no knowledge, or little at best, of an individual member.

Vocational Tests.—The correlation between levels of intelligence and the distribution of men amongst various occupations has given great impetus to the development of tests to determine occupational fitness. This presupposes an analysis of the occupation itself to determine the peculiar abilities that it requires. It is implied in this statement that maximum service from tests in relation to the choice of an occupation or to the choice of employees by employers of labor calls for a variety of tests that is limited only by the variety of classes of occupations.

During the World War many of the larger munitions establishments adopted tests to guide them in the selection of workers and in their assignment to particular sorts of work. Wherever this was done the output was increased, a high average of quality was maintained, the labor turnover was greatly reduced, and more than that, the morale of the workers was kept at a high pitch. This result, however it came about, is of topmost value in itself. Shells must be inspected before they are loaded and they must be gauged for head-thickness. A description of this work will help to make it apparent what personal abilities and traits are desirable in connection with it.

First as to inspection: a large quantity of brass shells is thrown upon a table with raised edges. An inspector takes up one handful after another, being careful to have them all pointing in the same direction. Then, clasping

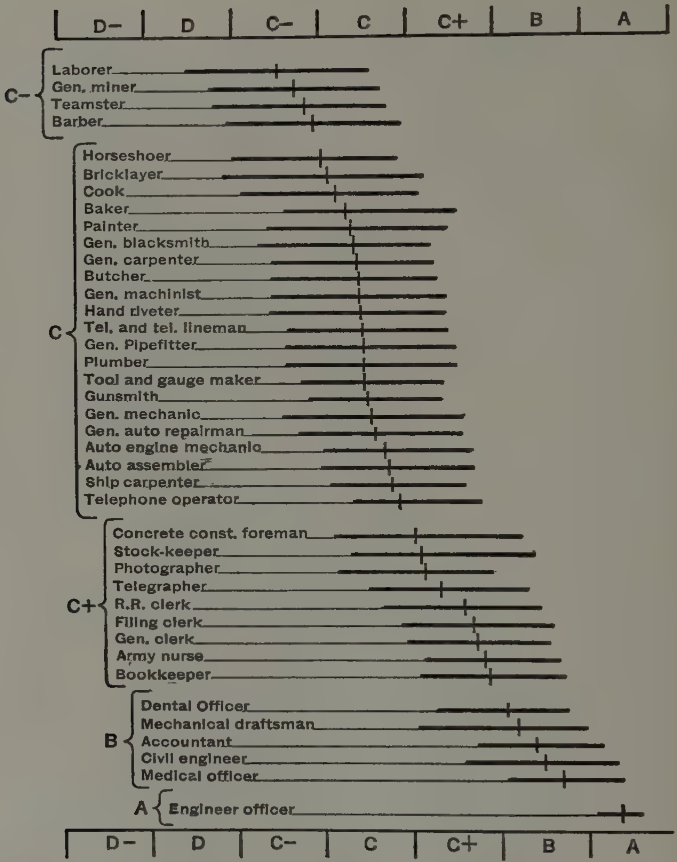

FIG. 42.—Success in civil occupations compared with army test records. The figure shows in a general way the correlation between intelligence as measured by the army tests and intellignce as indicated by position in civil life. From p. 829, *Memoir XV*. (After Brigham.)[1]

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[1] Seashore's Introduction to Psychology. Copyright 1923 by The Macmillan Company. Reprinted by permission.

them with both hands, turns them up so that he can see within them. He must look into each one of them to discover dents, scratches, oil-stains, and other minute defects. The good ones are thrown into a receptacle that is prepared for them and the process is repeated with each succeeding handful.

This operation requires the coöperation of several qualities: good vision to detect very minute defects; keen visual discrimination to distinguish, after a few glances, the defective from the perfect shells; quick motor reactions to extract, as soon as it is seen, the imperfect shell from those around it, and to toss it to the box prepared for it; accuracy of movement to pick out the particular shell that is to be rejected and not another one; steadiness of attention to avoid allowing a bad shell to escape observation.

Eight tests were available as a means for selecting employees who possessed these qualities.

The first was simply a test of eyesight. In the second the subject was given a pack of 49 cards. Upon the face of each of these were from seven to twelve letters distributed promiscuously. Twenty of the cards contained the letter "O" and the rest did not. The subject was required to sort these cards into two piles: one to be composed of cards with "O" and the other of cards without it. The time required for this performance was taken and the number of errors was recorded. The object of the test was to bring out the essential element from a heterogeneous collection of elements, and also, in some measure, to discover his deftness in handling cards.

In the third place the subject was confronted with a cancellation test. He was to draw a line with his pencil through every "7" upon a printed page.

Errors and time were recorded as in the card test. This was followed by an "Easy Directions" test. A printed page was presented to the subject; upon it were directions relating to things he should do. For example: "Look at the three blanks printed below. On the first blank write the number of days in a week, on the second the number of months in a year, and on the third the number of years in a century."

The fifth was a number-checking test in which the subject was asked to place a check after every group of digits in a column that contained both a "7" and a "1."

In the sixth place the subject was given a tapping test in which he was required to depress, repeatedly, a telegraphic key to which a counter was attached, and to do it as rapidly as possible. The number of recorded thrusts in the period of one minute was the record for the performance.

The seventh was an accuracy of movement test. The subject was confronted by a brass plate with nine holes in it. The holes were of diameter varying from ½ to ⅛ inch. He held in his hand a metallic pointed pencil, which was wired in circuit with the perforated brass plate. Whenever the pencil came into contact with any part of the brass plate a click was produced in a receiver at the subject's ear. It was possible to project the pencil into any hole in the plate, against the insulated bottom, and to withdraw it without making a contact, and therefore, without producing the click. In fast work, however a high degree of motor accuracy was required to avoid it.

At the beginning of the test the subject was instructed to thrust the pencil into each hole in succession, beginning with the largest one on the left and proceeding to the smallest on the right. Whenever a click occurred he should stop and begin again as before. The procedure occupied from two to three minutes. The speed of movement was regulated by a metronome so as to allow thirty trials a minute.

The eighth and last was a steadiness test. Two brass bars were provided. These were set in the form of a horizontal V. These bars were wired in circuit with a slender brass rod that the subject held in his hand. He was asked to take the pointer and to pass it from the opening at the left toward the right between the bars. The outer end of the rod was unsupported even by contact with a surface. The farther the pointer was moved toward the right the narrower was the space within the V bars. The problem is to go as far as possible without touching them. Whenever there is a contact an electric circuit is completed and a click is produced in the telephone-like receiver. The point at which contact is made is read upon a graduated bar. Each subject is allowed fifteen trials and the average of the last ten readings constitutes his record in the steadiness test.

The foregoing is typical of a great many occupational tests. Each one of them presupposes a preliminary analysis of the occupation to isolate the part adjustments that it requires; and after that the discovery of a test of the capacity of the subject for performing each part adjustment.

Tests of Musical Ability.—Tests of special musical ability afford additional illustration of psychology applied to the task of determining in advance the capacity of an individual for achievement in a specialized field. This may be described as a mental measurement rather than as a test. Musical talent consists of excellence in capacities that are essential for appreciation, rendition or creation of music; this in addition to a fair level of intelligence. The following from Seashore, is a representative list of factors in musical talent:

I. Musical sensitivity
    A. Simple forms of impression
        1. Sense of pitch
        2. Sense of intensity

        3. Sense of time
        4. Sense of extensity
    B. Complex forms of appreciation
        1. Sense of rhythm
        2. Sense of timbre
        3. Sense of consonance
        4. Sense of volume

II. Musical action

Natural capacity for skill in accurate and musically expressive production of tones (vocal, instrumental, or both) in:

1. Control of pitch
2. Control of intensity
3. Control of time
4. Control of rhythm
5. Control of timbre
6. Control of volume

III. Musical memory and imagination

1. Auditory imagery
2. Motor imagery
3. Creative imagination
4. Memory span
5. Learning power

IV. Musical intellect

1. Musical free association
2. Musical power of reflection
3. General intelligence

V. Musical feeling

1. Musical taste
2. Emotional reaction to music
3. Emotional self expression in music

Most of these capacities are measurable as a whole, as in the first four items, or in isolated specific aspects of a general capacity, as in the last group.

Figure 43 is a typical chart of musical talent. It is a report upon a gifted ten-year-old girl based upon laboratory measurements.

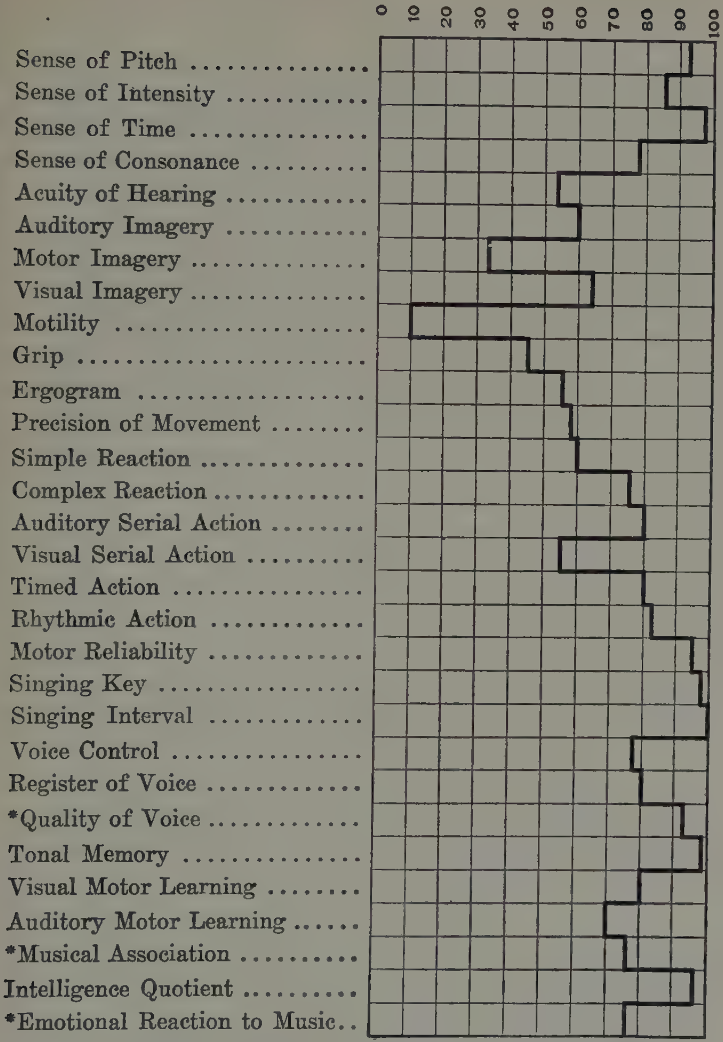

FIG. 43.—Musical talent chart of Theodora X.

The items marked with an asterisk in the chart represent mere estimates in the absence of norms.[1]

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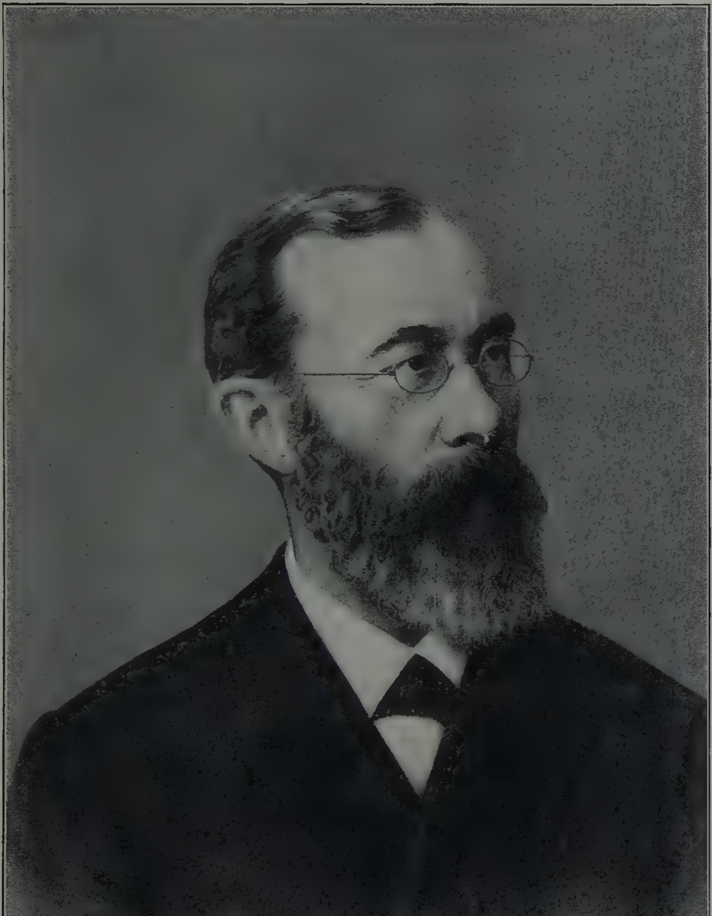
[1] Seashore's Introduction to Psychology. Copyright 1923 by The Macmillan Company. Reprinted by permission.

The chronicle of the case runs as follows:

Theodora has a decidedly musical mind. In the three basic capacities for musical hearing—the sense of pitch, the sense of intensity and the sense of time—she is superior and well balanced. Her sense of consonance is of a high order. Her acuity of hearing is only average, but this condition is not of the type which will affect music seriously in view of her superior sense of intensity. Her imagery is all of the moderate type. Her auditory imagery can be developed as an excellent support to her superior sensory powers and the motor and visual imagery are prominent enough for an emotional background in music. Her lowest record is on motility, which is characteristic of the fact that she has a deliberate type of mind and is steady in her movements. Her physique is average, as indicated by her grip and ergogram. Her precision of movement and her simple response to a simple signal are slightly above the average; while her simple response to a complex signal is decidedly better. Her capacity for serial association of sound and action is good; whereas her association for visual impressions and action is barely above average. Her timed action and her rhythmic action are both good. Her general motor reliability is superior. She sings in key with remarkable ability and reproduces the interval with superior precision, although her voice control is only moderately good for nuances of pitch. She has a good voice register and an excellent voice quality. Her tonal memory is decidedly superior. She gives superior promise for speed and reliability in the acquisition of skill in music. Her associations are highly versatile and remarkably well balanced, but not peculiarly musical. Her mental age is fully two years in advance of the normal. Emotionally, she is cool and undemonstrative, but capable of deep feeling for music.

Measurements of this type serve as an inventory or a budget of the talents that are available for a career.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(*See p.* 455)

A study of school children by means of these measures has revealed countless cases of talent hitherto unrecognized and undeveloped; has helped in the identification of known talent by objective analysis; has furnished explanation of the exhibition of unusual talent; has certified the absence of talent; has illustrated in a striking manner the magnitude of individual differences; has enabled the teacher to verify theories of talent; has shown that musical talent is equally distributed among high and low; has put the problem of the bright and the dull in a new light; has proved that it is possible to test the trained and the untrained alike; has shown that pupils in singing are not ordinarily grouped on the basis of talent for singing; has proved that likes and dislikes as stated by children and even by adults are a very doubtful indication of talent; has demonstrated that musical talent may be measured as early as in the fifth grade, or the tenth year; has opened a new approach to the study of musical inheritance; and has awakened the teacher to an interest in the study of the pupil as an individual. It has set an example of a scientific approach to the problem of the conservation of human energies, especially the more precious talents.

PERSONAL TRAITS OTHER THAN INTELLIGENCE AND SPECIALIZED CAPACITIES

The title of this section is not intended to suggest a sharp division between "personality traits" on the one hand and intellectual qualities and "specialized capacities" on the other. We have already pointed out that all these traits are intimately interrelated. It has become customary, however, to make a division here for convenience of description and discussion.

In no small measure the recent overwhelming emphasis upon non-intellectual traits is a protest against the earlier tendency to label an individual with a letter or two, supposedly indicative of his intelligence level and accordingly to push him up or down stairs at once. It is a recognition of the complexity of the person.

Many a keen observer of human nature is able casually to make a workable classification of the individuals he meets. Some such observers have made out schedules of physical signs by which, taken as a whole, they believe they are enabled to make personality judgments. With each of these signs, such as the square chin and forehead and form of the nose they have correlated a character or personality trait. But when the disinterested student attempts to parallel them with known traits he is balked. The characteristics referred to are what one may call static traits. It is entirely probable that those who succeed in classifying individuals after casual observation base their judgment not upon the static traits referred to, but rather upon *behavior signs.* At the same time they may be entirely honest in their belief that their conclusion is drawn from physical or static characteristics. After dining once with an individual many a man can determine whether he wishes to employ him or not. His speaking a few sentences reveals volumes about his social and educational attainments. A few minutes' conversation will often bring out considerable data about a person's range of training and information about his general emotional and mental balance.

No doubt we always will, in practical life, estimate the human material with which we are thrown in this somewhat casual manner. But it is extremely desirable that the process be systematized as far as possible and reduced to formal routine.

Systematic Observation of Personality Traits.—Many attempts have been made at systematically observing and describing the personality traits of one's associates. We are now thinking of personal characteristics that do not appear in static physical form, but such as, in popular speech, are described as "mental," or as "character," or as "personality traits." Much of the literature relating to this matter may be subsumed under the title "Personnel Rating."

The data that serve as cues for estimating these traits are obtained either through answers to questionnaires or by means of rating methods.

The first of these is an attempt to obtain a view of the personality of an individual by means of what his associates say in answer to questions concerning his characteristic reaction to various types of concrete situations. For example: "Is he talkative or taciturn?"; "Is he punctual and thorough?"; "Have you ever seen him angry? If so, how frequently and for what causes?"; "Is he prudish? If so, in what respects?"; "Does he display aversion, indifference or repression in relation to any particular topic? If so, what?"; "Does he seek or shun companions?"; "Is he easily brow-beaten or is he dominating?" "What personal defects does he acknowledge?"; "Does he blame others for his failures?"; "Does he have a favorite recreation? If so, what?" "Is he adjusted to the moral standards of society?" From answers to such questions as these the student draws inference relating to the subject's specific traits.

The value of the questionnaire will be determined by the degrees of conscientiousness and of slap-dashery respectively of those who make reply to it and by the nature of the question. It is fatal to introduce queries of a general character. They must be definite and must relate to concrete situations. But after all the result, generally speaking, is an impression of an individual and impressions are only a second or third rate substitute for an estimate based upon controlled analysis.

Personnel rating systems have grown out of a desire for more accurate descriptions of personality than are afforded by the questionnaire and for results that can be expressed quantitatively. There are two varieties of rating: scoring and ranking.

The scoring variety may be illustrated by the procedure in the army, when an officer was being rated with a view to his suitability for promotion. In the first place personnel officials agreed upon several qualities each of which was deemed to be extremely desirable in an officer. Now when an individual was to be rated each of three raters who know the subject were asked to think of officers within the scope of their acquaintance who possess each of these qualities in turn in maximal degree and of others who possess the same qualities in minimal degree. They were to select others who in their judgment possess the qualities in intermediate degrees. In the next place they were to compare the subject being rated with those officers in the personified scale. The subject was then given a mark of 1, 2, 3, 4, or 5, according as, in respect to ''ability to command'' for example, he was considered as like the lowest or the highest or an intermediate in the ideal scale. This method secured a certain degree of objectivity for personnel rating and probably protected it, as far as protection can be had, against the intrusion of personal likes and dislikes and other subjective factors that are inevitably involved when men and women are being placed upon a scale of value. Withal, however, it is admittedly a crude tool. The only claim that can be made for it is, first; that it is better to have the judgment of three than of one, because of the frailty of human nature, especially when that one is of superior rank; and secondly; that it introduces a degree of systematic objectivity into the process. These advantages probably outweigh the disadvantage that inheres in the obvious clumsiness of the method.

The ranking method of personnel rating is applied by individuals who are a part of a group to all other members of the same group. Each rater ranks each other member from highest to lowest in respect to each quality to be considered. Each individual may have therefore, as many ratings as desirable within the limits of the group and his average rating on each quality. His average rank respecting each quality is taken as a measure of the man *in relation to others in the group.*

The reliability of all such methods as this depends upon the validity of personal judgment applied to the qualities of men. A number of experiments have been made to determine this. Those qualities for which there is objective evidence such as vulgarity, intelligence, beauty and conceit, quickness, originality, efficiency, ascendance—submission, expansion—reclusion and social adaptability, are judged more reliably than the more subjective traits of snobbishness, refinement, introversion and emotionality. That is to say the judgments of a group of raters are more uniform with respect to the former than to the latter.

Handwriting.—The urgent need for a classification of types of personality and for criteria by which they may be identified have led to numerous attempts at finding a quarry in handwriting.

Professor Binet, for instance, has undertaken to correlate eminent attainments with handwriting characteristics. Thirty-seven individuals of great eminence were selected and each of these was paired with another of mediocre attainments but of similar social level and opportunities for education. Samples of their handwriting were placed before seven expert graphologists with the question which, of each pair of samples, is from the more eminent person.

M. Crepiux-Jamin made a score of almost 92 per cent. Others made 86, 83, 80, 68, 66 and 61 per cent respectively. These records are distinctly better than chance.

The graphologists assert that they read character by such signs as the following:

Ambition—lines of writing slope upward.
Pride—lines of writing slope upward.
Bashfulness—writing is traced with fine lines.
Force—heavy lines and heavy bars upon the t's.
Perseverence—long bars upon the t's.
Reserve—closed a's and o's.

A detailed attempt has been made at the University of Wisconsin to find correlations, in turn, between these characteristics of handwriting and the supposedly corresponding traits. Each of seventeen students copied a paragraph from a popular magazine, writing at his own desk in his own way. Every student was then given sixteen cards upon which were the names of all the students in the group, except his own. He was asked to rank the persons named upon the cards from high to low considering first the degree of ambition; secondly the degree of pride; thirdly of bashfulness, etc., that seemed to be apparent in those whose names were upon the cards respectively. The samples of handwriting were then examined and finely measured with a view to describing accurately the characters upon which the graphologists allege that they base their judgments. No positive results whatsoever were forthcoming, when an attempt was made to correlate measurements with the traits mentioned above.

Psycho-Analysis.—But the most impressive, and no doubt the most promising, application of psychology to the practical problem of classifying personalities is that which is suggested by the term psycho-analysis, a term that needs protection against certain unsavory connotations. The derivation and meaning of the term are apparent: an analysis of the psychic compound.

The psycho-analysts are responsible for having injected several new terms into the vocabulary of the psychologist; *"subconscious mind"; "subconscious"; "subconscious experience"; "the unconscious";* these terms have been repugnant to psychologists of the most conservative sort—and naturally so. For them psychology has to do with consciousness; with conscious processes and nothing more. The unconscious is outside of their realm and "subconscious mind" and "subconscious experience" are contradictory in themselves. These last terms have all but simmered out of existence over the heat of discussion pro and con but *the unconscious,* in spite of philology and history, bids fair to prove non-volatile and to hold for itself a respectable place in the language of psychologists.

The word has broad and varied connotations. Many nerve impulses do not arouse conscious processes for the reason that they do not reach the cortex; and yet they affect our behavior most usefully. Witness the rider upon a bicycle. Slight tippings from side to side that are not represented in consciousness at all are followed by bodily adjustments such as slight bearings upon the handle bars that elude attention and that result, notwithstanding, in the rider's maintaining his course; this is the outcome, for the most part, of stimulation within the semicircular canals of the inner ear, that has already been described as the sensory organ of equilibrium. The processes that are indicated here are open to demonstration in the laboratory and they are a part, though a small part, of the unconscious.

Many a student has gone to bed and fallen asleep after having vainly attempted to solve a mathematical problem and has awakened in the morning with the solution all in order. Something had gone on in the meantime, albeit unconsciously. It was an unconscious process. (See the topic "Dreams" Chapter VII.)

In our youth we learned certain mathematical formulae and acquired facility in applying them, but to-day we are wholly unable to recall them voluntarily, to say nothing of using them. Nevertheless we are able to relearn the formulae with ease. They "come back" to us after a little expense of effort and we quickly regain facility in their use. We had forgotten, but plainly we had some advantage from the lost material, and it performed a useful function in the process of relearning. The residua, we may say, of the formulae were in the unconscious.

Our likes and dislikes: we can usually give no reason for their existence. Occasionally, however, a satisfying *raison d'être* is forthcoming and without aid from others than ourselves. For example, without rhyme and without apparent reason, we have formed a dislike to an individual to whom we have lately been introduced. In the course of time it occurs to us that the mole upon his face makes him resemble Mr. A who acted meanly a year ago and for whom we had formed a violent dislike. In this case our emotional reaction had its root in the unconscious.

But the unconscious is not only a residue from the experience of a life time. It is, in larger measure, conceived as the left-over of the psychic history of the race. The experiences of thousands of generations are written into our personalities. And just because we are animals with an inestimable span behind us we are equipped with native dispositions, the foundations of which are unconscious and which unconsciously tilt our interests and desires independently of the experiences we may have had in the short span of an individual's lifetime.

We could indefinitely multiply instances of the functioning of unconscious factors in thinking, remembering, perceiving, and in other activities. The concept of the unconscious has come to stay, apparently, and psychology can no longer be written without taking cognizance of it.

The Complex.—The residua of experiences that are retained in the unconscious, even though we are unable to recall them and to make use of them, are conceived as forming complexes. These are attitudes or dispositions. They furnish impulsions in our daily life; impulsions that are a corner-stone of interests. Indeed we may truthfully say that in each of us are as many complexes as interests. There are the political, the religious, the economic, the sporting complex and others too numerous to mention. There are the complexes that center about self protection; fear and pleasure complexes in endless variety. In every case the complex is bound up with an emotional tone. (Indeed this is implied in the statement that complexes are corner-stones of interests.) By reason of its impulsive and emotional aspect the complex may be a highly disorganizing element in psychic life. Witness the obsessing fears of the psychopath.

The Conflict.—But the disorganizing process suggested here becomes real only as a result of *conflict* amongst complexes. It is a matter of common observation that clashes occur amongst our impulses. The tragic history of many characters in fiction and in real life is a tale of inner struggle that will not down; that leads to the goal of mental wreck or at best an unsatisfactory compromise that leaves the subject unfitted to fill the niche in life that he might otherwise occupy with credit. We are all familiar with neighbors who are suffering from an inferiority complex; who are without good reason borne down by a consciousness that they compare illy with their associates and that they cannot compete with them on equal terms. It may have arisen from a specific humiliating failure, for example, in public speech, the memory of which with its emotional setting, one has vigorously sought to repress and to thrust once for all into the realm of forgetfulness. This inferiority complex, whatever its origin, clashes—let us say—with a social complex that finds its expression in a desire to lead in a profession; and the conflict ends in a hopeless compromise. For the subject resorts to phantasy in which he regales himself with visions of himself triumphant and he is satisfied therewith. Or he may assume the manner of bombast and thereby restrict his social usefulness. But this does not exhaust the enumeration of possible resolutions of the conflict. The victim may become a chronic grouch; he has never had a chance; the hands of men are against him; he mentally projects upon others the weaknesses and meannesses that he recognizes in himself. Finally the conflict may run, in its last stage, in such a hypothetical case as we have before us, into the delusions of the insane. We should not infer, as many have done erroneously, that complexes and conflicts that crop out in every day life as phantasies and grouches and in manifold other ways, are necessarily pathological. Emphatically they may belong to normal individuals. Only in extreme instances may they be described as pathological. Here as elsewhere amongst psychic phenomena no hard and fast line may be drawn between the normal and the pathological. There is quite as arbitrary a division here as that between a gulf and the ocean.

Criminology.—Investigations into intelligence level and into other personality traits have been made very useful in relation to problems of criminology. How intelligent is the criminal and what personality traits has he that may have a causative bearing upon his antisocial behavior? Low levels of intelligence were in the past so uniformly reported by investigators in courts, reformatories and prisons that, in wide circles, it had come to be generally believed that these low levels loomed large as causes. In fact, in certain quarters it was loudly protested that here were the only causes worth considering. Poverty and other untoward social conditions as well as the commission of crimes and misdemeanors were interpreted as effects of low grades of intelligence. The feeble-minded, we were told, would make a hovel out of Fifth Avenue and the higher grades of mentality would, conversely, make a Fifth Avenue out of the back alley.

But the more common sense view has gradually reasserted itself: that the persistent circumstances with which one is surrounded are to be interpreted as so many stimulations or situations that induce reactions and fixed attitudes or dispositions that are closely analogous to professional natures. These acquired dispositions find expression in behavior that is appropriate to them precisely as a jurist's acquired professional traits are expressed in the behavior of a judge on the bench. By the same token one who has grown up in the midst of untoward circumstances where he has for years reacted to real or imagined oppression may develop a disposition that leads to antisocial behavior. The strongest natures, to be sure, may be expected to rise above these circumstances but that is too much to expect of the weakest.

This view finds some support in the history of intelligence testing amongst delinquents, juveniles and adults. In years past investigators have reported an approximate average of 50 per cent of the population of reformatories and prisons as of such low intelligence as to create the presumption of feeble-mindedness. Here and there, in its highest reaches the per cent ranged to 80 and above. At the opposite extreme per cents as low as ten were reported.

During this period, one of the obstacles in the way of reliable results lay in the fact that no sufficient data were at hand to indicate the reactions to intelligence tests on the part of normally behaving non-criminals. This want was supplied by the psychological examiners in the course of the World War and more uniform methods of procedure were established than had been in use theretofore. One result has been that reports upon examinations of prison and reformatory populations and of juvenile delinquents made since the war are indicating a percentage of low intelligence levels barely greater than were found among recruits by psychological examiners in the United States Army during the war. And this is no doubt properly assumed to be near the intelligence level of the population of the country at large. The post war examinations referred to have already been made in such number and to such extent as to fortify the negative of the hypothesis that low intelligence level is an important cause of criminal behavior.

Not only have investigations of the last few years gone against the theory that there is an enormous per cent of persons of very low intelligence level amongst criminals and juvenile delinquents; but there is a respectable showing of evidence for the view that intelligence levels of all grades are distributed amongst them approximately as they are found in the population as a whole. At any rate the intelligence levels found recently in a group of more than 1200 juvenile delinquents in Boston display a nearly normal distribution from superior to very low.

These findings add force to the view that the outstanding causes of anti-social conduct, so far as they can be discovered by an analysis of the individual, are to be found in *character traits*—to use an old fashioned term—or in personality traits as the phrase has come generally to be rendered. The term connotes all those evidences of an unstable constitution that are a large part of the stock in trade of the psychiatrists and mental hygienists. These are eccentricities, compulsion neuroses, delusions, psychoses of every sort, ''grouches,'' ''mental twists,'' etc.; all of which are interpreted as evidence of repressed complexes that, owing to social taboos or to limitations of other sorts, cannot find direct expression in the individual's adaptation to his world. They find their outlet therefore indirectly in signs or symbols of the complex—or better in symbols of an incompatibility or conflict amongst complexes. For example, a delusion of persecution: an individual, though he is striken with poverty, believes, as a matter of fact, that he is the rightful owner of rich oil wells in Oklahoma and that members of his family are depriving him of his property. His false belief is a symbol of an inner conflict between complexes, one of which is an inarticulate but consuming yearning for a competence; and the other a gnawing realization that because of inferiority it has not been attained. The symbol—the delusion—may ultimately be more than just that; it may at last become the motor phenomenon of killing, of striking or of other criminalistic behavior.

Psychology Applied to the Handicapped.—Those who have been handicapped by lack of limb, of speech, vision or hearing have for long been objects of study with an eye particularly to their relief. The problem in such cases is to lead the handicapped individual to develop habits of using what capacities he has in such manner as to make good, as far as may be, for those that are wanting. In other words we are concerned with the development of a substitution. The lack may be congenital or it may have been acquired; and the two situations present very different characteristics that are of extraordinary importance for the psychologist, the physician or the teacher—whoever he may be—who is the engineer in the process of building up a substitution.

What we have in mind here will be made clear if we will consider the victim of motor aphasia. His speechless condition has been acquired some time subsequent to his having built up speech habits. Such a person can recall speech, and this implies at least some knowledge of how speaking feels in his mouth, larynx and chest; he commands an array of motor, auditory and even of visual images that are associated with his own acts of speech. It is entirely probable that he retains ability to utter a few very highly habituated words, and ability to place the vocal organs for utterance.

On the other hand, the person who never acquired the art of speech, by reason, it may be, of total deafness from birth or from very early childhood, has no such imagery available. He has no hang-over of speech habits. There is little for the psychologist to build upon. He must approximate to the creation of a new structure.

In either case the problem is to build up some useful habits employing whatever foundation may be at hand.

In the case of the motor aphasic, we have in the few words that, we assume, he is able to utter, a convenient point of departure. If he can say "breakfast" the probability is that he can be led to utter any one of the component sounds in isolation. In the next place he can be induced to recombine a few of these components to form a new compound, "b-e-s-t," for instance, and "t-e-s-t." The process probably involves a substitution of one brain source of motor impulse for another that formerly supplied energy to the very set of vocal organs that we are now trying to get into properly coördinated activity.

The person who, by reason of early deafness, has never acquired the coördinated motor habits of speech, presents a different situation. He lacks the kinaesthetic, and auditory, and tactual and visual sensations and imageries that the normally speaking individual associates with his own speech and that serve him as criteria of correct utterance. The auditory factor is probably the most important of these. It is, above all, by means of hearing our own voices that we become aware of the imperfections of our speech and our auditory images become the criteria of excellence. The totally deaf who hears not even his own voice has but two guides and two criteria remaining: (1) his motor and tactual sensations that arise within his vocal organs and in his finger tips, too, if they are in contact with his teacher's throat; (2) his observation that others behave as if they understand or as if they misunderstand, what he is attempting to say. But impressions from these sources are by no means always adequate.

The author is making very successful experiments upon a supplement to all current methods of developing speech control. By means of an electrically operated device the vocal vibrations of a leader are communicated to the fingers, palm or other part of the body (depending upon the location of the pupil's "receiver") of each one of a group of cases. No two of the long vowels, for instance, feel alike. They differ as to roughness, heaviness and length. One is heavy or rough here and another there: ā, for instance, is heavier at the beginning than at the end. A high pitch is always lighter and smoother than a low pitch. By means of a duplicate transmitter or mouthpiece each member of the group can take his turn speaking against his own skin and the skin of his companions and of the leader in an attempt to reproduce the tactual criterion with which he has become familiar in the course of the experimental procedure. Pitch, accent and enunciation of words can thus be controlled at one and the same time; and in the utterance of sentences pitch, accent, enunciation, rhythm, tempo and emphasis are under simultaneous control. In these experiments the sense of touch is given a very greatly enlarged usefulness as a guide and criterion of correct speech.

Not only the sense of touch but that of vision also may substitute for hearing as a guide toward correct speech: vision of lips and larynx in action—and much more. For the form of the vibrations of a speaker's vocal apparatus, may be thrown upon a screen as a waving line of reflected light by aid of a suitable device—the oscilloscope. The patient can see the effect of perfect speech. He can see the effects of energy, of pitch and enunciation, in the case of words in isolation. He can go about it to produce these effects one at a time and all together. It is like shooting at a target and seeing where the bullet strikes. Ultimately he forms an association between a visual sign of correct pitch, for example, and a group of kinaesthetic sensations. Thereafter by dint of kinaesthetic memory he can reproduce pitch at will without visual aid.

The tactual *feel* of words and sentences in the same series of experiments is being made a means of substituting for hearing in understanding speech as well as in vocal control. The almost unbelievable sensitivity of the skin enables one, after sufficient practice, to make distinctions amongst words where very minute differences are involved. This fact opens up the possibility of learning to receive speech by touch. No two words feel alike when the vibrations that correspond to their utterance are communicated to the skin as tactual stimuli. They can therefore be identified by touch when tactual memory has been established; their "feels" can be associated with meanings precisely as hearing people make such associations with complex pushes of air against their auditory organs. It is only a step from this point to combination into sentences and paragraphs.

Incidentally a group of deafened subjects can obtain simultaneously by touch a feeling for the swing of a sentence; its tempo, rhythm and varying emphasis that they have been unable to gain otherwise. These characteristics of the spoken sentence, indeed, go so long a way toward conveying meaning to us all that their tactual correlates in the deaf are no doubt of really more than incidental value.

By the same token that the visual effects of spoken words is a means of furnishing cues for correction of speech, they may also be the means whereby the deaf may receive and understand the speech of their neighbors. The very atmospheric vibrations that cause hearing people to *hear* and understand speech may cause deaf folk to *see* and understand; and we have already shown that they may *feel* these vibrations and understand. The devices to which we have alluded, whether they are for communicating tactual or visual stimuli, are only convenient means to aid in bringing the characteristics of speech into attention.

The central idea in what we have been saying above is at the core of a great chapter in applied psychology. Pseudo-paralytics and true paralytics; those who have suffered the loss of arm or leg or both; all these are being helped over their difficulties by application of methods that it is the business of some psychologists to cultivate. When an arm has been lost the remaining muscle groups must get into the way of expressing habit sets to which they have not heretofore been accustomed. This implies a long period of careful training. By hook and by crook the learner, from the beginning of his apprenticeship, must have had his attention drawn to the kinaesthetic or motor-sensation-factors that are involved in a successful adjustment. It may be necessary for the director or teacher, whatever the psychologist may call himself for the moment, to put the learner passively through the movements of adjustment over and over again in order that he may come to know how the successful adjustment and the process of attaining it should feel. For example a boy has never used his right arm and hand. According to external appearances he is paralyzed. Diagnosis indicates that the mechanism of arm, hand and brain is intact. The trouble is that in early infancy there was a block in the way of exercising the arm. Notwithstanding that the hindrance is no longer in existence the youngster does not now move his arm. He cannot for the reason that he never has done so. This situation was briefly discussed in Chapter XIII in relation to voluntary action. It may be interpreted as an illustration of the application of psychology to some practical problems of volitional control. In early childhood there was sufficient reason for his inability. In later years his motor incapacity was due to his not having acquired the kinæsthetic background. The wise teacher, physician or psychologist passively moves the arm; he draws the patient's attention to the feel of the movement and to the visual appearance of the arm in motion. Not only the arm but ultimately the fingers are treated in this manner, and repetition is the watchword. At last the young patient is able to take care of himself; his pseudoparalysis has vanished. Its disappearance has come along with the acquisition of new motor habits and they in their turn have waited upon the building up of a suitable kinæsthetic-sensation background. We can do no voluntary act unless we have already done something similar to it.

All the foregoing so far as it relates to a discovery of the causes of irregular behavior and to maladaptions of whatever sort; and so far as it relates to a treatment of the individual to the end that he may be helped through his peculiar difficulties may loosely be described by the phrase "Psychology in Relation to Medicine," as well as in relation to voluntary action.

Psychology in Relation to Law and Legal Procedure.— Whenever the irregularities of individuals are taken cognizance of in the light of the well-being of a group, as the citizens of a state, we are face to face with Psychology in relation to law and legal procedure; assuming that the "irregularities" and the "well-being of a group" are such as are taken cognizance of by the law.

The law exists primarily for the whole body of citizens. It protects the individual or it prosecutes him as the case may be, because it conceives such action as in the interest of all to the end that all may live together in a sense of security. The law is then figuratively interested in whatever the psychologist may contribute toward improvement in procedure if only the contribution is such as, when put into practice, will enhance the well-being of the social order.

Such enhancement follows the presentation of the fullest array of facts in a case at the bar. This is practical justification for psychological investigation relating to two great problems:

(1) The methods of accumulating evidence.
(2) The value of testimony.

Pursuit of the first problem has been on the assumption that knowledge of one's own guilt will show itself through an emotional tone that affects associative responses and that arises from glandular and motor reactions.

The reaction tests have grown upon this soil. If one sets out from a key word such as "lock" and pronounces successively one word after another as it comes to mind one will sooner or later run into a group of words that suggest one's sources of satisfaction, or dissatisfaction, or anxiety or what not. If one has been implicated in a crime it is probable that one will give an important clue before the time is up. A variation of this form of test is found in the case in which the examiner has prepared beforehand a series of 100 or more words. He asks the examinee to respond as quickly as possible by pronouncing the first other word that comes to his mind when the examiner pronounces one word after another until the series is completed. In the prepared list are several "critical" words, so-called because they refer to the criminal act in which the examinee may have been involved. Thus if it is a purse-stealing case, the word "purse" in the list is "critical"; the word "meadow" is "non-critical." If the examinee is guilty of stealing, he will probably make a delayed response to the "critical" word and his response when it comes will be striking because of its unusualness, as an associate with "purse." It may even be an incriminating associated word.

In another type of test the examiner observes the motor reactions of the heart and the respiratory apparatus; the speed and accuracy of motor responses and glandular activity indicated by the psycho-galvanic reflex whilst the examinee is under a fire of questions some of which relate directly to the circumstances of the crime that is under investigation.

Investigations of this character have not yet yielded a method of examination that is deemed fit to stand alone. They have, however, brought clues to light that have led to the clearing up of cases. Undoubtedly we have here useful supplements to traditional methods.

A great amount of experimental work has been done in relation to the second problem named above: the value of testimony. The by-standers and even the participant, ordinarily know very little of what actually happened in an exciting situation. On the whole the examinee's narrative contains more truth about the situation than do his replies to questions. But it has long been recognized that the form of question designated as "leading" is by no means desirable as a means of getting at the facts. There are many degrees of "leadingness." Muscio[1] has discriminated eight forms of question and has concluded that the most reliable is that which relates to the actual seeing or hearing of an item: one that uses no negative term and no definite article.

The Psychology of Advertising.—The working of an advertisement is a case of stimulation and response. Certain printed words, colors, lines and figures are the stimuli; the coming forward of purchasers to buy or at least of prospective purchasers to make inquiry are the responses.

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[1] "The Influence of the Form of a Question." *British Journal of Psychology.* Sept. 1916.

Ideally the advertiser takes it for granted that certain wants already exist amongst the members of his "public" and that these wants must be satisfied. In practice he no doubt goes a long way toward *creating* the feeling of wants. He takes it for granted also that he has the means to satisfy them. Therefore he proceeds to let prospective purchasers know—to bring it to their attention—that he has the means of satisfaction. The study of the psychology of advertising is the investigation of the most effective manner of attracting the attention of the buyer. It must appeal at once to interest, emotion, memory, habit, suggestibility and will. It must study the effect of position upon the printed page; size of type, weight and direction of lines; pleasantness of color, figure and a score of other factors. Distraction of attention or arousal of antagonistic reaction may follow upon an ill arrangement.

Educational Psychology.—It is in the field of education that psychology found its first practical application. It is here that it comes into its most fundamental contact with daily human life.

In this relation as elsewhere it proceeds from an analysis of the matter with which it is dealing. What in particular are the characteristics of the young at successive stages of their growth? This question has elicited volumes upon volumes of literature descriptive of the learner's motor capacities, likes, or inclinations toward action, fears, memory, capacity, sensory and perceptive powers, imagination, religious life, etc. It has been the ideal of educational psychologists from the beginning of their systematic attempts at analysis to catalogue the most complete possible list of characteristics and so to describe them that they might be recognized by teachers in their daily work. The accomplishment of this descriptive task should guarantee that we know what we have to start with; what is the material we have to work upon.

The curricula of studies and opportunities for play and work are stimuli in psychological terminology. They are brought to bear experimentally in a wide variety of circumstances. In the next place the process of experimentation will show what product may be got when we have such and such a nature given and such and such a stimulus to apply. In other words educational psychology is interpreted another case of a study of stimulation and response.

Analysis of the human personality, incomplete as it is, reveals such an enormous array of characteristics! Their permutations are without number. The concourse of stimulating circumstances cannot always be under experimental control, and therefore responses called psychological can never be foreseen with as great accuracy as those other responses called physical and chemical. This enhances the tantalizing character of psychological investigation.

CHAPTER XV

A SKETCH OF THE HISTORY OF PSYCHOLOGY

> "When a thought of Plato becomes a thought to me—when a truth that fired the soul of Pindar fires mine, time is no more. When I feel that we two meet in a perception, that our two souls are tinged with the same hue, and do as it were run into one, why should I measure degrees of latitude, why should I count Egyptian years?"—EMERSON

Why this Chapter Is Introduced.—Psychology is an old science—one of the oldest. Men of all races, in all ages and climes, have been interested in human nature. Every new generation has had its sages or scientists who have endeavored to explain the phenomena of life, sentiency, and consciousness. It happens that the psychological notions of the past have had a peculiar vitality, out-living their times and often descending into our own day, to constitute a part of the heterogeneous mass of notions that enters into the composition of our culture. It is astonishing to observe how many historical conceptions of the nature of man are still current. They may be met in casual conversation, in the popular press, in general literature, and even in learned treatises.

It will be an advantage to the student to be able to recognize them; to know something about their history and influence, and how they bear upon present-day ideas. For this reason it seemed to us desirable to accompany our study of contemporary psychology with a brief sketch of the history of psychological ideas. It is scarcely necessary to say that the study of the history of the subject is of great importance to anybody who desires a satisfactory understanding of the psychology of the present. In this brief sketch, however, we cannot pretend to completeness or adequacy. Or, again, particularly in modern times, we cannot stop to justify or explicate interpretations of psychological movements which may appear to more advanced readers to require serious qualification. This chapter is for the beginner, and he may at least gain from it a slight knowledge of psychological conceptions which have been really influential in the history of thought.

Primitive Notions.—Primitive man, we commonly say, is an "animist." He is a believer in *ghosts*. From a very remote period men of almost all races have entertained the belief that the living man differs from the corpse in that his body contains some subtle thing or principle which determines its purposive movements, its growth and self-repair, and to which his capacity for sensation, thought, and feeling is due. The belief in some such animating principle, or soul, is held by almost every existing race of men, no matter how lowly their grade of culture or how limited their mental powers; and there are evidences of a similar belief among the earliest human records.

This animating principle is usually thought of, at the lower levels of culture, as a kind of shadow-like duplicate of the human body, which leaves the body at death to wander away into some ghostland below or beyond the solid plane of our earthly existence. The primitive man tends to think of this ghost in substantial terms. The ghost has a body; a material body, more intangible and evanescent than this human body of ours, but made of some substance that has physical properties. The ghost, again, is a very close duplicate of living man in his mental and moral traits, and in his activities. He eats, desires, suffers, hates, has prejudices. It is quite needless to point out that this primitive ghost-idea is still current among us.

Who has not shivered over tales of haunts and visitations: of "materializations" and the pranks of spirits in the seance-room?

The ghost-soul of the primitive man had its logical justification. In a very rough way it served to explain sleep, death, coma, stupor, and like phenomena. When a man sleeps, it was thought, his soul quits his body, leaving it insensible to its surroundings, wandering in strange places, beholding strange sights and having weird adventures. In the stupor of sickness the soul departs, or withdraws, for a time, and must be coaxed back by enchantment and magic rites. In death the soul leaves the body forever; but sometimes it hovers, for a while, about its earthly abode, and must be appeased with gifts and proper funeral rites.

If the ghost-soul was of some service as an explanatory principle, it at the same time offered the primitive poet a splendid opportunity for the exercise of his fancy, of which he was not slow to take advantage. The ghost-soul is, accordingly, a thing of intellect and phantasy oddly compounded. Even our more civilized notions, indeed, are often embellished with fancy and the ornaments of imagination. But we have learned fairly well, at least, to keep scientific explanation to itself, free from fiction. Our scientific treatises, as a consequence, are apt to be, from a popular point of view, *dry*—lacking in emotional color and playful allusion. The superior picturesqueness of the primitive ghost-soul may in part account for the continued survival of the conception and of the term "soul" in psychological literature almost to our own day. The intangible character of the term and its connotations—to say no more of it—makes it a highly undesirable element in the vocabularly of science.

Greek Thought.—Psychology, as a systematic form of inquiry, makes its first appearance among the ancient Greeks. "If by science," says Windelband, "we understand that independent and self-conscious work of intelligence which seeks knowledge methodically for its own sake, then it is among the Greeks . . . that we first find such a science. . . .'' It is true that the Greeks, even at their best, never advanced very far with experimental and inductive scientific processes. But they established the language of our sciences. They laid down fundamental conceptions which have served as a basis for all later reflective constructions. For this reason the philosophy of the Greeks has never been out-worn; we must perpetually return to it for an understanding of the elementary categories of our sciences.

The systematic thought of Greece had its origin, apparently, in Miletus, of Ionia, in the sixth century B.C. Thales (about 600 B.C.) is the earliest scientific thinker of whom we have any information, and this, indeed, is very scant. He shows an independent line of reflection in his assertion that the (φύσις), the elemental stuff of which all substances are composed, is *water*. For water has a peculiar mobility with regard to its states, and is present almost everywhere in nature. And perhaps for this reason it occurred to Thales that water might be the elementary substance of which everything is composed. His conclusion was trivial, but his method was not so. Here, for the first time in history, we find a deliberate attempt to understand nature as it is in itself, and to explain it in terms of itself.

We cannot undertake here to trace the very interesting development of Greek thought that occurs between the times of Thales and Socrates. Psychological ideas were, in the beginning necessarily crude. The earlier thinkers, like Thales, tended to identify the soul with the universal ''nature'' (φύσις) out of which all things are made and to which all return. But as time passes we find the Greeks attaining an ever more adequate apprehension of the nature of the specific problems which confront the student of human nature and human consciousness. By the time of Democritus and Socrates Greek thought had gained tremendous vigor along all lines of inquiry. It reached its culmination in the great masters, Plato and Aristotle, whose influence upon later ages is incalculably great.

In the course of the development of Greek thought there appeared (about 450 B.C.) a class of professional teachers, called Sophists, who aroused great interest in the study of man as a thinker. The Greek people, witnessing the growing influence of systematic thought, desired to take advantage of such scientific methods and results as were available, in order to promote their practical affairs and interests. The Sophists, accordingly, started to teach science and mathematics, and, following a popular demand, rhetoric and the art of persuasion. But then, as now, the teacher of public speaking and of salesmanship, education and politics, felt the need of knowledge concerning the human will and intellect, concerning the emotional life and the reasoning faculties. So the Sophists taught psychology, after a fashion; a sort of applied psychology. Such psychological and logical science as the Sophists developed was, to be sure, lacking in substantial content. But they aroused a demand for knowledge of the human mind which started speculation to moving vigorously along that line.

Socrates (469–399 B.C.), known chiefly for his ethical teachings, was in many respects vigorously opposed to the Sophists. But he shared with them a profound interest in the intellectual processes of man, even at the very point where he differed with them most acutely. His famous dictum, "Virtue is Knowledge," sums up very neatly his ethical conclusions, and indicates the high degree of importance which he assigned to the cognitive faculties. Socrates' interest in cognition was, as we would say nowadays, epistemological and logical. He was concerned with the problem of truth and the question how we may attain assured and objective knowledge. But in the quest for a test of truth Socrates was led to a study and analysis of our conceptions and of the higher thought processes generally. The work which he began was taken up and carried on by his great disciple, Plato (427–347), who pursued it vigorously and passed it on to Aristotle (384–322) who gave us our first systematic treatise on psychology.

Plato.—Greek thought, especially through Socrates, as we have seen, came to be directed upon the human thought-processes themselves. What is truth? How may we reach it? What is science? These are questions which commanded Plato's earnest attention. They have to do, as will be seen, with the nature of thought itself, and with our instruments of knowledge. We cannot follow Plato in his discussions of these difficult problems, except as they occur in the course of his distinctly psychological inquiries.

In Plato the primitive soul idea still persists—but in a transformed and highly metaphysical form. It is true that in discussing the soul, and especially its immortality, Plato frequently expresses his ideas in poetic and mythical form. But in his scheme of human nature the soul has a definite place and function, and he frequently writes about it with a scientific spirit almost modern in its critical severity. First of all let us observe that Plato considers the soul to be *immaterial.* It is no longer a ghost, a substantial image of the body. For the body, according to Plato, is merely phenomenal; it is a thing of the sense world, a mere appearance; it is ephemeral and unreal. Its characteristic function is to know. It is synonymous with Mind. It is a kind of immortal intelligence or principle of knowledge.

In the earthly state, however, the soul is attached to a body, through which it exercises certain lower mental functions, the emotional and appetitive. In this doctrine Plato introduces the non-cognitive mental processes. He goes here beyond Socrates, in the direction of an empirical psychology which takes account of the real complexity of man's mental life. He develops it, indeed, to the point where it serves as the basis for a whole scheme of education and social regulation. Most of these ideas will be found in the *Republic*.

In Plato's naïve language there are three "forms" of the incarnated human soul: a cognitive or rational form, an appetitive or "desiring" form, and a spiritual or emotional form. The rational soul—perhaps Plato speaks here only figuratively—has its seat in the head, a place of honor, elevated above the grosser parts of the body. For it is this part of the soul, as we have seen, that is divine, and deserving of the highest place. The appetitive part of the soul has its seat in the abdomen, and is the lowest and least dignified part of the soul. The ardent, spirited nature is located in the thorax. It is the source of courage, righteous anger, and the manly virtues. In the normal man these three parts of the soul are harmonious with one another, and form a perfect unity under the control and guidance of the reasoning part. Plato, like most of the Greeks, emphasized the idea of proportion, of balanced unity in multiplicity. The ideal man is not one who is *merely* intellectual as might be anticipated from what has been said above, but he is the man who possesses all the faculties natural to human kind, in proper proportion and degree, all under the sovereign guidance of reason.

It has been suggested that these three "forms" of the soul do not, in Plato's theory, represent merely static divisions, but rather, levels of mental development. This may be true in part, since Plato was forced to recognize that few individuals approximate the ideal human type, which is essentially intellectualistic. In the *Republic* the citizenship of the state is divided into three classes: the industrial class, which provides the necessities of life, and is fit only for such labor, since the individuals who compose it are lacking both in intelligence and spirit; the soldier class, given to deeds of prowess, serving the state as guardians, but lacking in rational insight; finally, the men of intellect, to whom the management of the state should be entrusted, since they alone are good judges of what is good and true. Plato does not mean, apparently, that the laborer lacks *all* intelligence; rather, that he is not fully developed. The guardian class represents another step ahead, and development culminates in the man of wisdom, the philosopher. And so, although Plato nowhere emphasizes the notion of "levels of mental development" his statements lend themselves readily to genetic interpretation. His treatment is a suggestion of our modern discussions of individual differences and vocational aptitudes as determined by degrees of intelligence.

In the end, it will be seen, Plato exalts reason and the life of reason, as Socrates had done before him. With Plato this enthusiasm for the intellectual life is due in great measure to his high regard for science and scientific ideals. He believed it possible to do away with the uncertainties of "rule of thumb" experience, to get beyond the vagaries of mere "opinion" and, through the exercise of reflection, to arrive at positive knowledge of the nature of things. In his scientific program he seems to have provided scarcely at all for what we now call the *inductive* scientific processes.

As we have evolved a whole system of geometry from a few simple axioms and postulates, so Plato seems to have thought that all our scientific knowledge must be deduced, by logical reasoning, from assured premises. This statement requires some qualification, to be sure, but in the main it holds not only for Plato but for all the Greek thinkers. In Aristotle we find the beginning of a purely inductive procedure, but it was never developed, by his successors, into a form of what we now call the experimental method.

Plato's regard for reason impressed his immediate followers, and all later generations. His conception of human nature has endured down through the ages, and is still a living force in our social, moral, and religious thought. These ideas of Plato, indeed, are so familiar to most of us that they seem common-place when they are presented.

Aristotle.—Aristotle's treatise, *De Anima,* marks an epoch in the history of psychological thought. The great Stagyrite summed up the results attained by his predecessors in the psychological field and brought them, together with original data, into a system impressed with the stamp of his unique genius. Even today his work stands as a land-mark toward which thinkers frequently retrace their steps in order to get their bearings. Within the past few years there has been a distinct revival of interest, in this country, in Aristotelian conceptions. This tendency is especially conspicuous in the movements known as "functionalism" and "behaviorism."

To the present-day student the work of Aristotle will seem much more "scientific," objective, and inductive, than that of Plato. And, indeed, we do find in Aristotle a more direct interest in Nature, a keener eye for concrete observation, a greater inclination toward empirical investigation, than is shown by any of the great thinkers of antiquity. Reality, for Plato, was a realm of "pure ideas" lying above and beyond the sense world; but Aristotle found the real embodied in the individual concrete objects that men perceive, that make up the world of our experience. And so he was led to seek for reality in phenomena themselves; to explain nature in terms of its own inner rationality. His tendency, accordingly, was inductive, observational and experimental. Aristotle sketched, in outline, most of our fundamental sciences, assigning to each its field of inquiry and its underlying conceptions.

The one central notion in Aristotle's philosophy, which gives it its peculiar distinction, is that of *development*. He was, in the broad sense of the term, an evolutionist. But here he must be classed with the "vitalists" rather than with the "mechanists." For everything that lives and grows, he thought, is *besouled;* is explicable only in the light of an inner *essence* or principle of determination that gives form and organization to the matter in which it is embodied. The soul is not thought of as an independent and pre-existing entity that brings the body into existence, but simply as the cause and principle of life; a vital principle inseparable from the body of which it is the "form." "Soul is the primary actuality of a natural body endowed with the capacity of life. . . . It is, therefore, unnecessary to ask whether body and soul are one, as one would not ask whether the wax and the figure impressed on it are one, or, in general, whether the matter of a particular thing and the thing composed of it are one."

The concrete nature of Aristotle's conception of the soul appears when we begin to dip into the details of his psychological writings. Soul shows itself first of all in the vegetative functions of plants and animals. It is the "form" of the mechanical and chemical changes which enter into assimilation and reproduction. Above this level we find the animal soul, which reveals itself in the added functions of locomotion and sensitivity. Human souls are manifested in the activity of rational thought, peculiar to man. The individual man, then, is vegetative, animal, and rational (a division reminiscent of Plato). But we have, of course, not three distinct souls, but a unitary vital principle manifesting itself in various functions of the life process in man and at different levels in the organic world in general. The conception is definitely genetic. It is distinctly closer than the theologian's "soul" to the present-day notion of mind.

Aristotle's knowledge of physiology and anatomy was extremely limited. He did not even understand that the brain is the bodily seat of intelligence. His discussion of the instinctive, emotional, and sensory processes, consequently, often goes astray, though it never fails to be interesting. Aristotle was, to be sure, keenly aware of the poverty of his information, and pointed out the necessity for a better understanding of the bodily processes. He realized that the soul must be studied in its concrete manifestations, as a form of bodily activity. His psychology was of the type that we nowadays call *objective.*

Aristotle's doctrine of the rational soul of man has been the occasion of many a wordy dispute. In the main, as everybody agrees, Aristotle recognized that intellect is dependent for its functioning upon the body as a whole and upon the capacities for assimilation and sensation in particular. This concrete human intelligence he distinguishes as the "passive" reason—and he asserts that it can have no existence apart from the body of which it is the soul.

But he is uncertain on the subject of the creative, or "active" reason. The active reason is, as Ward says, "rather theological than psychological; it is in the main his philosophical version of the widely held belief in man's participation in the divine." But even here Aristotle never committed himself unreservedly to the statement that the active reason can exist in an unembodied state. With scientific reserve he suspended judgment pending further information concerning the bodily processes involved in thinking.

Aristotle's psychology is characteristically objective, as we have said. He shared this tendency with Greek thought in general, which turned naturally outward, upon the world, rather than inward. Aristotle's standpoint is not only objective, but biological. And in this he formulated and systematized one of the logically fundamental methods of psychology.

The Inner World of Consciousness.—In passing from Aristotle to Descartes we span a period of nigh two thousand years. We must pass over these ages with a few brief notes. For, however interesting the nature of man as developed in Hellenistic and Patristic times may be for the historian, it must be admitted that they contributed few positive additions to our stock of psychological ideas.

After Aristotle (d. 322 B.C.), Hellenistic thought appears to have reverted, for a time, towards a materialistic conception of the nature of man. The classical exposition of materialism, among the Greeks, was that of *Democritus* of Abdera, a contemporary of Socrates, who has, indeed, been ranked with Plato and Aristotle as one of the greatest of the Greek philosophers.

According to Democritus, the universe is to be understood as a mass of atoms in motion, a conception very familiar to us in its modern scientific form. All change, qualitative as well as quantitative, is to be interpreted as due to the displacement and rearrangement of atoms. They have hooks, eyes, grooves, humps, and are of various sizes, so that as they move about they become interlaced with one another, forming the bodies which constitute our world. The soul and mind of man were, by Democritus, unhesitatingly included in the atomic scheme of things. The soul of man consists of the "same atoms which constitute the essence of *fire;* the finest, smoothest, and most mobile." Perception and thought are explained as a kind of interaction between the soul-atoms and the grosser atoms of the body and the external world.

It was through the influence of the Neo-Platonists (who exerted a great influence upon the Church Fathers) that this crude materialism came to be set aside in favor of a more subtle and refined conception of the human spirit. Plotinus reaffirmed the Platonic notion of the soul as an immaterial principle, pure spirit, wholly distinct from anything that is corporeal. St. Augustine defined matter as spatial and extended substance; spirit as an equally real but non-extended substance. With this distinction clearly before him he was led, by his religious conceptions, to place emphasis on the importance of the spiritual life, and thus he came to a sense of the reality of man's inner life of thought and feeling. "He had moved," says Windelband, "the principle of *internality* (*Innerlichkeit*), which had been preparing in the whole closing development of ancient science, for the first time into the controlling central position of philosophic thought, and the position to which he is entitled in the history of philosophy is that of the beginner of a new line of development."

This development did not occur at once, however. In the Middle Ages we discover tendencies, especially among the mystics, towards a controlled study of man's inner consciousness. The importance of inner experience in the religious life of an increasing number of devotees served to draw attention to this inner world and to emphasize its reality. But in all this, it will be seen, there is no more than a slow and gradual refinement of ancient ideas. Left to itself it is doubtful whether it would ever have led to a more scientific understanding of human nature. But when the notion of "inner experience" was finally brought into contact with the genius of modern science it led to some remarkable developments in the psychological sphere.

Descartes.—The refined and spiritualized conception of the human soul which developed in the course of mediæval thought did not disappear with the rise of modern physical science. For natural science attempts to explain external nature in terms of time and space, motion and mass, and excludes all "anismism" from its scheme. Under this way of thinking spirit and mind disappear from the external world, leaving the human consciousness an isolated phenomenon, to be surveyed and studied by special methods. This contrast between physical nature and consciousness appears in striking form in *Descartes*. His "dualism" set a fashion in men's ways of conceiving mind in relation to the world that has profoundly influenced the development of modern psychology.

René Descartes (1596–1650) was a Frenchman. He contributed considerably towards the development of the natural sciences; was an expert mathematician, the founder of analytical geometry; was active in astronomical, physical, and optical research; was a student of anatomy and physiology. In all such branches of inquiry he asserted the supremacy of a purely mechanical method of interpreting things. Physical nature, throughout its range, he thought, is to be explained by means of such conceptions as geometrical space, time, divisibility, mobility, and measure. He himself attempted a mechanical theory of the evolution of the heavenly bodies. He went so far, indeed, as to insist that even living bodies, animal and human bodies (as bodies), are mere machines, explicable by a mechanical science.

But the human mind, he thought, is excluded from this program of scientific explanation. *Material substance* alone can be explained mechanically; *thinking substance* must be explained by entirely different principles. Mind is not a mechanism. It does not occupy space, does not move in space, is not subject to the causal laws that govern matter. And thus we have a *dualism* of the two great orders of existence, matter and mind. The one is what the other is not. They are defined in antithesis to one another.

The trend of Descartes' philosophical argument shows that he holds consciousness to be the *immediately* known reality: external nature is known only through the *medium* of thought. *"Cogito, ergo sum"* (I think, therefore I am), is his ground premise. I know myself as a thinking being more clearly and distinctly than I know any outer reality. For he says, "the notion that we have of our own minds precedes that of any corporeal thing, and is more certain, seeing we still doubt whether there is any body in existence, while we already perceive that we think." It is clear, then, that Descartes accepted mind as a reality quite distinct from matter. And this opinion is still further enforced by the extent to which he interested himself in purely psychological problems.

We have then, on the one hand the unextended thinking substance and on the other the extended substance of external nature (including the body). But mind *is* somehow related to the body; our thought does express itself through nerves and muscles. Since they are wholly unlike and incomparable kinds of reality, how can mind be said to affect the body? How, indeed, can the two be related in any intelligible fashion? Descartes there raised a difficulty that has troubled philosophy and psychology most profoundly.

Descartes himself assumed, in a somewhat naïve way, that mind *does* somehow act on the body. He was specific enough to assume that this action takes place through the pineal gland. The soul is able, he thought, by affecting it to determine the motions of the body through the nerves, and thus to put its purposes and plans into the form of concrete action. Although Descartes' physiology was very crude it may be said. nevertheless, that the form of *interactionism*—between body and mind—which he taught is still held, in principle, by certain contemporary psychologists.

This Cartesian dualism had, for psychology, the effect of bringing the *subjective* point of view into the foreground. Under this theory the mind must be studied introspectively, as it appears to the thinker himself. "This restriction of psychology to the immediate facts of consciousness," says Ward, "as these exist for the conscious subject, was a great advance over the confusion of psychology with biology which characterized the Aristotelian and scholastic doctrines. As a result, the science made more progress in two centuries than it had made in twenty centuries before."

Beginnings of Neurological Research.—This statement needs some qualification. Wittingly or unwittingly Descartes, by way of his dualistic conception, furnished the incentive to certain of his contemporaries, and to others who shortly followed him, to examine the mechanistic point of view. Accordingly we find about this time a considerable drift in the direction of anatomical and physiological research. Whether those who were setting out to pursue this course were intent upon contributing to an understanding of the mental nature of men or to some other problem is of no special consequence in this connection. The fact is that they launched a campaign of magnificent proportions that has eliminated "animal spirits" from the vocabulary; established the rôle of mechanism in many departments of human conscious activity and enlarged its scope without defining the ultimate source of the energy that created the machine and set it going, or even seriously attempting to describe it. Psychology has responded to the impress of this line of research and certain contributions to our knowledge of human nature that have been made thereby, are wholly indispensable to the psychology of our century. Thus the realm that Descartes excluded from the entrance of mechanistic conceptions has been successfully invaded. Indeed when Descartes was but a young man, Harvey, in 1628, had discovered the circulation of the blood and had thereby dealt a body blow to the hypothesis that "animal spirits" flowed through the natural channels of the body and established "sympathy" and coördination amongst the parts of the organism. Thomas Willis (1622–1675), who was to some degree a pupil of Descartes, and from whom he acquired his bent for the study of the nervous system, published his *Cerebri Anatomi* in 1664 and left his stamp upon cerebral physiology. But a little later Astruc of Montpelier (1684–1766) rigidly carried out the suggestions of Descartes and devised a mechanistic conception of the origin of sensation and motion.

Next among the high lights who lived at least in the shadow of Descartes was Robert Whytt (1714–1766) who vigorously attempted to break away from the over-worked ideas that clustered around "soul" and "animal spirits." He preferred "power or influence of the nerves." Whytt demonstrated the supreme function of the brain and spinal cord in relation to sensation and coördinated movements. At the same time he repudiated the doctrine of a pure or completely mechanical human nature. He enlarged the scope of mechanism in relation to human behavior.

Thus was the study of human nature well headed in the direction of research by objective methods practically within Descartes' own time and under his own impetus. This represents a tendency, in the main, toward mechanism. At present we will pursue this line no farther but will return to it later. Suffice it to say now that the distinction of having advanced the science of psychology through the last two centuries must be shared with physiological and anatomical research.

The subjective point of view in psychology, which Descartes' dualistic conception brought to the fore, has had an important bearing on the development of the science in modern times—in spite of its shortcomings. In its earlier course, at any rate, it has appealed to the speculative turn of mind. Like the objective view-point it has sometimes led to conclusions that are favorable to mechanistic conceptions. For the present we will follow its course through a brief space.

Forms of Dualism.—The abstract separation of mind and matter which dualism sets forth presents enormous difficulties so long as their relationship remains unformulated. A simple way of escape from this baffling situation, and one that has recommended itself to a great number of thinkers, is to reduce everything to either matter or mind. In this case matter or mind, as the case may be, is said to be the *reality* and the other member of the dualism is said to be one of the manifestations or "appearances" of the fundamental reality. Thus Hobbes, following closely upon Descartes, tried the expedient of reducing mind to a form of physical motion. Sensation is a form of motion in the body; feeling a form of motion about the heart. For Hobbes the notion of the soul (as a non-physical reality) is a delusion. Our psychic life is to be understood through and through in terms of the mechanical motions of material substances. This form of theory is known as *materialism*. But Hobbes, it may be remarked in passing, was not a consistent materialist. Although materialism has had many advocates in modern times it has never exercised any very great influence in the scientific or philosophical worlds. Its limitations are many and obvious.

The *spiritualists,* on the other hand, have tried to make mind the primal reality and to show that matter is only one of the special modes or manifestations of mind. Unqualified spiritualism has had less to recommend it to scientific and philosophical thinkers than has materialism.

In the main our most influential thinkers have held that while matter and mind cannot be reduced one to the other but are equally real or unreal, they nevertheless are related to one another in some definite and determinable fashion. They have their unity within some larger system which includes them as moments, phases, or aspects of the whole: something beyond our immediate experience.

One of the most interesting and influential of these attempts to overcome the abstract dualism of Descartes is to be found in the monistic system of *Spinoza* (1632–1677). Spinoza taught that soul and body (thought and matter) are not two distinct *substances* but two out of many attributes or aspects of the *one* real substance, God. Mind and body, then, are related as *aspects* of one world reality. Nevertheless they appear to us, in our finite situation, as parallel and concomitant series of phenomena. Every mental state has corresponding to it a bodily state. The mind and the body are one and the same thing, conceived at one time under the attribute of thought, and at another under that of extension. Spinoza's theory leaves us to explain material things in terms of material causes and connections and mental things in terms of mental causes and connections. There is no causal interaction between body and mind. From a scientific standpoint, we might say, mind and matter are separate; but metaphysically they are one. And so Spinoza set forth the identity-theory of the body-mind relationship which is now held by a number of psychologists.

Leibniz (1646–1716), like Spinoza, undertook to solve the problem of the relationship of mind and body in terms of an inclusive system. He finds the fundamental reality of the world, however, not in a single substance that expresses itself in varied attributes and modes, but rather in a *system of monads.* In his conception of the monad Leibniz inclines more than Spinoza towards a spiritualistic than towards a materialistic interpretation of the nature of things. The monad is a hypothetical center of conscious dynamic energy. Monads are of different orders. In their totality they constitute a system, not a chaos. God, the supreme monad, and the creator of all, so ordered affairs that each monad might fit into the universal scheme of things and yet remain itself, so that it might unfold itself without hindrance from other monads. This is the doctrine of *pre-established harmony.* The fundamental reality, then, is a system of monads. In connection with that system we must understand Leibniz's idea of the mind-body relationship.

The concrete human individual, in Leibniz's view, is a combination of monads; there are the inferior monads which appear to us as the body and constitute its ground of unity and there is the human soul. The soul monads and the body monads keep pace with one another in much the same fashion as two reliable clocks, when wound up, keep time with one another. Bodily changes and mental changes proceed in strict parallelism, and yet it cannot be said either that the body affects the soul or that the soul affects the body. Thus in the system of Leibniz, as in that of Spinoza, body and mind are parallel phenomena which find their ground of unity within a larger system rather than in direct relationship to one another. This was their solution of the body-mind relation.

In recent times opinion has been divided as to whether psychology is to be required to say just how mind and body are related: whether it is not rather the function of psychology to accumulate the facts of human behavior and to let hypothesis emerge at leisure. This is our personal view. It is held by some, however, that psychology may safely adopt the postulate of parallelism, as a working hypothesis. Under this theory we assume, simply, that bodily and mental changes are concomitant; we assume no form of interaction between them. Some writers, hold that parallelism is a barrier to the advance of psychological thought. In practice this division of opinion coincides rather markedly with the distinction between mechanistic and teleological systems which we shall presently have occasion to discuss. Meanwhile the mind-body problem is far from settled.

The Introspective Standpoint.—John Locke (1632-1704), whose *Essay Concerning Human Understanding* appeared in 1690, set a new fashion in our psychological ways of thinking. In his general standpoint he was a dualist, following Descartes in the supposition that there are two *substances,* the material and the mental. Locke was not, like Descartes and his Continental followers, an important figure in the development of the physical sciences. He took the investigation of the mental as a special problem to be treated by itself. He is only incidentally concerned, indeed, with the bodily processes which attend our thinking. "I shall not at present meddle with the physical considerations of the mind," he writes, "or trouble myself to examine wherein its essence consists." He confines himself to a study of the "discerning faculties of a man, as they are employed about the objects which they have to do with." In short, Locke studies the processes of the mind themselves; he adopts, in the main, the method of *introspection:* direct observation rather than mere speculation.

Locke is, in the first place, *empirical.* What, he inquired, does mind show itself to be when it is observed? When we direct attention upon our own consciousness we find our ideas—of sensation and reflection. With these, then, we begin our study of the mind. Our observation is limited to the thoughts and sensations of which we are aware and which we may attend to and describe. Again, Locke is *analytical.* His method is to discover, by introspection, the simplest elements of which our mental experience is composed, and afterwards to show how these are combined into the more complex forms of conscious experience. His method seems also, in the main, to be what we may call *descriptive,* as opposed to *explanatory.* He was content, that is, in studying the mind, to tell what is there and what goes on. *Why* the elements of consciousness combine in just the forms that they do take and why they follow one another in some one order rather than another, does not especially interest him. To be sure, it was his opinion that the explanation of mental changes is to be found in the thinking substance in which they "inhere." But that mode of explanation would not have carried him very far even had he chosen to adopt an explanatory attitude.

The introspective, analytical, descriptive method of Locke was continued by his immediate successors, Berkeley and Hume, and by a great number of students of the mind during the eighteenth and nineteenth centuries. It is, indeed, in fashion today. In many respects it has proved one of the most profitable of all psychological methods, especially when employed under the controlled conditions of modern psychological experimentation. The empirical standpoint of Locke gave great impetus to the observation of mental phenomena and cleared the way for systematic psychological investigation.

Associationism.—The influence of Locke and the other English empiricists went out in two directions which we must now follow. It gave rise, in the first place, to *Associationism.* Associationism developed in its most typical form in England although it had energetic followers in Germany and France. If, in our study of the mental processes, we employ a merely descriptive method, it is clear that the whole problem of the nature of the mind reduces itself to the discovery of the *laws* of sequence and combination which manifest themselves in the mental sphere. A law, in this sense, is nothing more than a record of what regularly happens or occurs in the mental sphere. *Why* things happen so is, from this point of view, a matter of no concern to the scientist. A number of associationists, notably *Thomas Brown* and *James Mill* held severely to a purely introspective and descriptive method in psychology. In the long run, however, explanation will not be denied. Why *do* our ideas occur as they do? Why do these several sensations fuse as they do; why does this idea invariably suggest *that* associate? Well, one may say, they just do and that is the sum of the matter. Science can say no more.

But as modern physiology and laboratory methods developed, and more and more came to be known about the correlation of our mental and bodily states, it was almost inevitable that we should undertake to trace the order and connection of our mental states back to the brain events which attend them.

But before we follow up the second line of development that followed upon English empiricism which was to mark out the neural connections in the groundwork of mental life and to penetrate that life with the mechanistic ideal we will very briefly sketch the modern idealistic thought.

Kant and the Modern Idealists.—In an indirect way, empiricism was the occasion for a movement in Germany which began with Immanuel Kant (1724–1804) and continued into the first quarter of the nineteenth century. The idealistic movement which he initiated has left a profound impression upon modern thought. Idealism took root, in the last quarter of the nineteenth century, in England, and has undergone considerable development in the English-speaking world. It furnishes, in a way, the ground upon which most of our contemporary systems of "self psychology" and "functionalism" are based. It is somewhat difficult to estimate the principal tenets of idealistic thought as these have affected psychology and psychological theory. But perhaps the following summary will be of some value.

(1) Idealism opposes the doctrine that human behavior is just a complicated effect of stimulations of such and such character.

(2) Idealism is generally opposed to the structural and "mechanical" logic of the associationist school. It refuses to interpret conscious experience and mental development in terms of "elements" and connective principles. In place of a scheme of elements and combinations there is an organic whole to begin with and association is explained by the discriminating and relating activity of the judgment process. The general view-point of idealism would seem to demand that what we call elementary sensations and the various qualities and characteristics of experience are gradually distinguished and cut out of the organic whole by the activity of thought.

(3) Idealism has always laid great stress upon development and genetic theory. Its method is typically historical whatever the particular subject treated. In this connection it should be observed that idealism does not, like certain other systems, reject the Aristotelian notion of final ends or purposes. It makes much of teleological interpretation, particularly in the mental sphere. This is shown especially in the emphasis that is placed on interest and selective attention as central processes of conscious life.

(4) From the beginning idealism has been interested in the customs, institutions, and objective constructions of man, since these are products of thought, and serve to reveal the nature of the activity which created them. The idealistic movement has fostered, accordingly, historical studies of religion, politics, morals, law, and folk and racial psychology. The study of social psychology, also, is agreeable to the idealistic temper of mind, for idealism insists that the individual mind is understandable only in relation to the social mind or mental community of which it forms a part.

It will be seen, then, that although idealism is not directly interested in psychology as such (any more than in any other distinct science) it nevertheless touches psychological theory at many points. For this reason it has exerted a much greater influence on the development of modern psychology than is generally understood. It is a force to be reckoned with in the intellectual world.

The Neurological Contribution.—It was inevitable, as we said above in our sketch of the Associationists and their laws of sequence, that men should attempt to trace the order and connection of our mental states back to the neural events that go along with them. The very emphasis upon *laws* of association was, at the very beginning, an incentive to the physiologists of the nervous system who were already in the field. This may be said to be the second line of growth from English empiricism; associationism being the first. It is equally correct, if not more so, to describe this movement as an outgrowth from Descartes. His barricade against the mechanistic principle was a challenge to the physiologists.

David Hartley (1704-1757) was the first English associationist to employ physiological explanation systematically in connection with associationism. He was contemporary with Astruc of Montpelier and Robert Whytt who were mentioned above as among those who, on the side of physiological research, set a tide toward mechanism in psychology. Hartley analyzed the mind introspectively and attempted to trace its connections in purely psychical terms. He held, theoretically, to the position that the mental processes are independent of the brain processes which parallel them.

But he was a physician; he knew something of the close connection between bodily and mental states, and made the study of this correlation a main part of his psychological inquiry. Thus arose a form of physiological psychology which reached its climax in the works of Spencer, Lewes, and Alexander Bain. In its fundamentals, indeed, it closely resembles a form of psychology which has developed in

Germany and in the United States in comparatively recent times and has influenced psychology profoundly.

In this connection it should be observed that modern physiology is typically "mechanistic." Descartes had held that the body is nothing but a machine; modern physiology, with its reflex-arc and nerve mechanics, shows us the details of the human machine. If then, mental processes are to be explained physiologically (a possibility which Descartes denied) it follows that we must think of man, fundamentally, in mechanical terms. A psychology which follows this plan is not "materialistic," in the ordinary sense of that word, but it is "mechanistic." The nervous system is the reality; mind is an appearance which can be explained only through the nervous system. The prevailing tendency in psychological thought today is undoubtedly mechanistic. "The evidence to-day," says Warren, "seems clearly to favor the mechanistic interpretation as a working hypothesis in psychology as in other fields of science."

The correlation in which Hartley was interested had been ascribed by Robert Whytt, as we have already pointed out, to the "power or influence of the nerves." It was left for Charles Bell in 1811 and for Magendie a little later (1823) to demonstrate that the posterior peripheral nerves are sensory and the anterior, motor; a law that stands, in its own sphere, upon the same level of importance as Harvey's discovery of blood circulation in relation to general physiology.

The theory of the specific energy of nerves was outlined in 1811 also by Bell. "An impression made on two different nerves of sense by the same instrument will produce two distinct sensations, and the ideas resulting will have relation to the organs affected. Piercing the retina with a cataract needle gives a flash of light, and a blow on the head, makes the ears ring and the eyes flash light, but no sound or light is present."

After these observations the reflex arc began to take the place of the spontaneous activity in all bodily and organic movements. Violent discussions of the mechanistic principle, pro and con, were the order of the day amongst physiologists themselves. Marshall Hall, in 1837, and his German translator, Kuerschner, were among its earnest advocates, but Volkmann in 1838 was in opposition. He denied the pure mechanistic doctrine relating to lower animals at least. In support of his position he pointed out that when such an animal has been divided a sensitive principle continues to be active on each side of the section. Witness the behavior of the body of a reptile that has been cut in two.

And now we find the physiologists contending with one another in their way concerning the soul; its divisibility and its particular location, if any, in the body. They were fortified by the results of methodical experiments. Many a frog and dog and salamander gave up his life in European laboratories, an unwitting sacrifice to science that these vexed questions in addition to problems of the particular character of mechanism, might be answered. There were volumes of discussion in Pflüger's *Archiv* of the ''spinal cord soul'' and of *souls* here and there presiding over every motor phenomenon; of consciousness and reason of every conceivable degree of clearness and specificity in relation to the same phenomena. The physiologists proved themselves as inveterate fighters as any others of their day—and prone, sometimes, to launch off into a sea of speculation beyond observed phenomena. But it must be said for the physiologists that *first* they observed and under conditions that were controlled as well as their times permitted, and that their speculations were suggested by the products of controlled observation.

It must be agreed that the partisans of the mechanistic theory—or better, of a qualified mechanism—emerged with an advantage. Longet showed as early as 1842 that the coördination of the muscular system is provided through the sensations of movement themselves: the sensation of one movement in a complex is the cue and control of the next, and so on till the series is completed. This observation is reminiscent amongst us of our own William James and—to be more personal—of our experience with a "sleeping foot." We are awkward in such a circumstance because we cannot be aware of the normal sensations of movement.

This brings us at last to the broad theory of Herman Lotze which was published in 1853. It is a theory of qualified mechanism. Though its author was speaking three quarters of a century ago he might almost be talking with us today. While he was writing particularly of reflex actions, his application was evidently to the great world of motor activities that are performed without the actor's conscious control.

Activities earlier performed in consciousness leave impressions behind them in the nervous system. Subsequent movements are dependent upon these impressions. In other words their origin is in the after effects of behavior that was once controlled by intelligence. We have here a mechanism not of the first construction but one of practice. Even our voluntary movements become graceful and manageable by this principle. Our gestures, mien and other forms of customary behavior, too, by the same token, are mechanical performances of secondary construction. Lotze had caught the idea of development from the conscious to the unconscious; the voluntary to the involuntary; from the spontaneous to the reflex. The discussions and the controlled observations of two hundred years had injected the mechanistic principle into psychology and the direct operation of the soul (by whatever name it may be designated) upon behavior had been very sharply limited in its scope.

It is, perhaps, worthy of observation at this point, that the bulk of the discussions amongst the nerve physiologists around the middle of the nineteenth century are really farther removed from the ancient soul theory than may at first appear from their continued use of the term "soul." In his "Physical Basis of Mind" (1877), Lewes, who was not far from the conclusions of Lotze, declared that vital facts, especially facts of sensibility, have in them factors that are neither discernible in machines nor expressible in mechanical terms. But Talma who much earlier than this (1842) had seen reflex phenomena, at least, in the same light as Lewes did, spoke of "indisputable proof for the existence of a spinal cord soul *insofar as one understands thereby a complicated action in the nerve cells such as is generally assumed to occur in the cells of the brain.*"

The fortunes of the mechanistic principle have been further advanced in studies of the cerebral cortex, especially those that have resulted in the localization of function already described in this volume. When Broca discovered the motor-speech area that bears his name, in 1860, great expectations were aroused that ultimately the entire catalogue of mental capacities and talents would severally be found to have their cortical location. These expectations have not been realized. Only the sensory and motor functions have found a place, and, incidentally, the assumptions of the phrenologists, therefore, are without a foundation.

Physiological optics and the physiology of audition and of other sense organs in addition to those of seeing and hearing make up a monumental total. Studies in these fields have developed the points of view that have been suggested in our chapter on Sensation. We are not attempting a historical sketch of studies in this field.

All this is only a glimpsing of an enormous range of activities in physiological research. A volume is too small space in which to do them justice. As far as we are concerned in this place, one of their most important net results for psychology has been to fasten a point of view upon it that has gradually edged it into the realm of experimental science. It is due in a very large sense to physiological research that the methods of psychology are as our laboratories employ them in our generation. It is due to it, in a measure, also, that the science is at last able to justify itself in its practical usefulness in the work-a-day world.

While these events were transpiring and bodily movements were being placed in the category of at least qualified mechanical processes very interesting developments were going on, chiefly in France, that have had a profound influence upon the psychology of our day.

The world had been turned upside down in certain quarters by the manipulations of "Mesmerists" as they were called. It showed how strong was the grip that ideas of soul and "vital fluid" and the like held upon the popular imagination. Long before the middle of the nineteenth century Alexandre Bertrand, a physician of Paris, gave an account of the phenomena much like ours of today. James Braid, an English physician, in 1841, independently published the same account and placed hypnosis, as he called it, upon a firm psychological foundation. H. Bernheim in 1884 placed the phenomena upon a physiological basis. More recently, through experimental studies of hypnosis by Pierre Janet and others, much light has been thrown upon the mental constitution and from an unexpected angle there has come a demonstration of the barrenness of the old psychology that relied upon introspection alone and figured as a department of general philosophy.

In fact it is to French students in the nineteenth century and to those of the present that we are especially indebted for the present state of our science with respect to abnormal mental phenomena on the whole. Jean Martin Charcot through his extraordinarily broad studies of the nervous system in morbid cases during the last quarter of the nineteenth century is probably responsible, more than any other one man, for the great interest that Frenchmen of the present day are manifesting in this quarter of the field of science. For Charcot was an inspiring teacher as well as a great investigator. The works of Janet on hysteria, the dissociated personality, obsessions and psychaesthenia are classics in their field. No special branch of our subject has more greatly influenced recent opinion in general psychology than these studies in mental pathology. And, of course, speaking of French psychologists, no statement would be complete without a reference to Alfred Binet. He was the father of the tests that bear his name and for that reason we may say that from him we have derived the application of the statistical method to differential psychology. In reckoning the sources of contemporary psychology in this country we must rank French influence among the foremost.

The Modern Psychophysicists.—The foregoing summary justifies the term ''scientific'' as applied to the nineteenth century and the latter part of the eighteenth. The growth and extension of the natural sciences during that period, the startling success of scientific principles in application to practical problems, the captivation of the intellectual world by what may be called the ''natural-science'' point of view, constitute the most interesting chapter in human history. As physics, geology, chemistry, physiology and biology advanced they contributed more and more in the way of detail to our knowledge of human nature. The most significant contributions were made by optics, acoustics, and neural physiology. As knowledge of the human sense organs and their capacities, of the nervous systems and its detailed workings piled up, there came a time when it seemed that the next step in order was to collect the scattered psychological facts which had accumulated, integrate and interpret them in the light of the new physiological science, and start psychology on a new scientific program.

Experimental Physiological Psychology had its origin in Germany during the last half of the nineteenth century. This is the customary arbitrary statement of the case. As a matter of fact, however, the roots of the movement are much farther back in the work of the neurologists and physiologists we have referred to in a previous section. A number of scientists contributed to its modern development —men of the rank of Weber, Helmholtz, and Müller. It was G. T. Fechner (1801-1887), however, who gave it its greatest impetus. Fechner was, in his philosophy, a "panpsychist." He believed, that is, that spirit and matter are coextensive realities: that they exist everywhere together. All matter is besouled. But how are body and mind related? The old vexing question over again. But Fechner sought to answer it by quantitative scientific methods. There must, he thought, be some mathematical correspondence between the physical and the psychical. To quote Dr. G. Stanley Hall: ". . . But how can we measure the psychical by the physical? This was a new ambition and a new problem over which Fechner brooded long, as Descartes did over his. And as Descartes suddenly hit upon his idea of the analytic method, so Fechner, on the morning of October 22, 1850, while ill in bed, first hit upon the thought that the increase of the subjective intensity of a sensation is proportional to the increase in the strength of the stimulus; that there were two series: the psychic increasing arithmetically or by a constant difference, and the physical geometrically or by a constant multiple. This thought made his book of logarithms almost sacred, for in it he found the norms he sought. From that time he began to weigh and measure. E. H. Weber had found that two lines were not recognized as different in length until one was at least one-fiftieth smaller than the other. This showed that the sensibility for the difference between the stimuli is dependent upon the magnitude of the stimuli, and in such a way that the greater the initial stimulus is, the greater must be the difference in order for it to be perceived.''

In 1860 Fechner published his *Psychophysik,* in which he set forth the result of ten years of experimental effort and careful theoretical study. The primary feature of the book is the ''psycho-physical law,'' which states that the intensity of a sensation is proportionate to the logarithm of the stimulus. In proving the law Fechner developed three methods: (a) just observable differences, (b) right and wrong cases, (c) average error. This scientific formula, supported by experimental evidence, and based on careful methods, attracted wide attention and aroused a great deal of controversy. It served as a great inspiration to workers in the psychological field. A great many psychologists of today date the rise of scientific psychology from the year of publication of Fechner's great treatise.

It remained, however, for another Leipsic scholar, Wilhelm Wundt (1832-1917), to establish experimental psychology as a university discipline and give it a firm foundation. In 1879 Wundt instituted, at Leipsic, the first psychological laboratory. Wundt was a thinker of remarkable erudition and breadth of interest. He wrote extensively during many years upon several subjects, including physiology, physiological psychology, general psychology, folk psychology, ethics, logic, and philosophy. With his extensive knowledge, encyclopedic style of thought, and empirical temper, he was eminently fitted for the task of gathering the scattered facts concerning human nature that had been accumulating in the sciences and putting them into orderly array for the constitution of a new science. It was his scientific training, especially in physiology, together with his understanding and appreciation of the work of Fechner, that gave him the special fitness for the task which he so quickly exhibited. Wundt's great contribution to psychology has been, of course, the establishment of the experimental method. He first standardized experimental procedure and revealed its possibilities. On the side of theory Wundt was conservative. He was a most careful workman. He defined methods and theories with great care, and exhaustively criticized them. It was his hope to establish the science of psychology on a secure and well-reasoned foundation as a distinct and independent discipline. There is nothing essentially novel, however, in his views of general psychology.

As a teacher Wundt inspired his pupils with the thought that psychology must cease speculation and go to work—carefully, methodically, experimentally, in the search for facts concerning consciousness. It is upon his work as a teacher, rather than as a writer (although one must not overlook the importance of his great *Physiological Psychology*), that Wundt's fame will ultimately rest. He deserves, by every test, to be called the "Father of Experimental Psychology."

In the eighties and nineties of the last century scores of American students went to Germany to complete their college studies and to do advanced work. Many of these young students became interested in Wundt's work at Leipsic, entered his laboratory, and returned to this country, bringing with them the "new psychology." The first laboratories in this country were founded by G. Stanley Hall and James McKeen Cattell. Soon psychological laboratories on the Wundtian model sprang up all over the country. Our universities were then in process of rapid expansion and development and opportunities for the teaching of the new discipline appeared everywhere and gave great impetus to the development of the science in this country. Only a short time ago psychology was taught as one of the special philosophical disciplines, having about the same status as logic or ethics has at present. At the present time most of our colleges and universities have separate departments of psychology, with well-stocked laboratories and complete equipment for their work. This development of psychology as a separate science must be traced back to Wundt and the Leipsic movement.

Other forces besides those in Germany, of course, have contributed to the development of psychological science in our country. Darwin's *Origin of Species* was published in 1859, about the same time as Fechner's *Psychophysik.* It is scarcely necessary to remark that evolutionary theories have exercised a large influence upon American thought, and in this connection we must not overlook the psychological writings of Herbert Spencer, whose influence has been tremendous. They are the direct antecedents of the genetic method in general psychology that for many years has had great vogue in America.

All lines meet, however, in *William James* (1842-1910), who, it will be generally conceded, has exercised more influence than any other American writer upon the development of the science as it exists in this country today—not excepting Wundt. James' life was practically contemporary with that of the great Leipsic psychologist. Like Wundt, he was a student of human nature in many of its various aspects. He wrote and taught in the fields of physiology, psychology, and philosophy alike. He had the same ability to gather and synthesize the multifarious facts that had accumulated in the course of the nineteenth century and to weave them into a coherent view. James' fame must rest upon his writings, rather than upon his work as a teacher. And, in particular, it must be remarked that he contributed to psychology, not a new method—as did Wundt—but new ideas and conceptions. He originated no school, but he has influenced all schools.

James' *Principles of Psychology* (1890) is one of the classics of modern psychology, and the regard in which it is held does not decrease with the passing years. It is impossible to attempt any summary of this great book. It is not a systematic treatise. Nowhere does James show a tendency to narrow the scope of his science in favor of some particular formulation. His book is a thing of loose ends and incomplete thoughts. Its virtue resides in its particular insights and keen analyses and interpretations. We may, however, notice as conspicuous elements in his thought, in the first place, his rejection of psychological "atomism" and the "compounding of states of consciousness." James, in the second place, has given a prominent place in his psychology to attention and interest as central processes in the conscious life. It is this element in his work that has made his writings so attractive to idealists and to students of applied psychology alike. James, that is to say, stresses the study of mind in its everyday workings, as moved by interest and desire. We may add, in the third place, that he tends towards what we now call the "functional" interpretation of consciousness. He interprets man, that is, as a living being placed in an environment which presents problems in the way of reaction. Intelligence is an instrument of adjustment.

James Ward (1843 ——) holds in England a place analogous to that of Wundt in Germany and James in this country. Many American students have been greatly influenced by the English Associationists, but the work of such men as Ward and Stout has attracted little attention in our scientific circles. Ward's best-known writing is the article on "Psychology" which first appeared in the ninth edition of the *Encyclopedia Britannica*, and has been retained in following editions. He contributed also many articles on psychology to the British journals. Only recently, in 1918, his *Psychological Principles* appeared, giving us for the first time in finished form the views which he has been teaching since 1878. The book is an imposing piece of work and presents, moreover, a point of view rather out of the beaten track of contemporary thought. It has the strong individual touch which characterizes the work of William James, but it is more systematic.

Ward is the strongest representative in modern times of a "self-psychology" projected against an idealistic background. Ward is a thinker who exhibits in his work a surprising range of knowledge and accomplishment, and a distinctly synthetic type of mind which enables him to systematize his knowledge in a remarkably effective fashion. Ward is a *general* psychologist; in no sense is he an innovator or specialist. His contribution to the science is almost wholly of a theoretical and interpretative character. "I never contemplated," he says, "more than an exposition of *psychology as a whole;* merely subsidiary details, however interesting, were beyond my purview." He had in mind to achieve that very inclusiveness and harmony which is at present so necessary and desirable.

Present-Day Schools of Psychology.—Interest in psychology has greatly increased, in all quarters, in recent years. And as the science has come to occupy an ever more conspicuous place in the college curriculum, as journals have been established, books published, associations formed, our science has come to bear more and more the aspect of an international enterprise. There is no such thing as a distinctly "American" form of psychology, although we have, to be sure, our own special interests and theories. In no country, perhaps, is psychological enterprise more diversified, and theory more varied, than in our own. We may, before closing this sketch, be allowed to say a few words about our psychological "schools."

We have, first of all our *Structuralists,* whose foremost leader is Professor E. B. Titchener. This is an introspective school, in the line of direct descent from Wundt. Experimental control of conditions is regarded as a means towards effective introspective analysis, which is held to be the chief business of the science.

This school is contrasted with a much more recent one, the *Behavioristic* school, which has gained many followers in the past few years. Its methods are wholly objective. It holds that introspective study can never be made scientifically exact. Man is to be studied as a natural object, interacting with other natural objects, and the purpose of psychology is to study stimulation in relation to response. It is directly descended from the physiological laboratory.

Functionalism is a genetic theory. This school interprets intellect primarily as an instrument of adjustment, enabling man to solve problems and achieve his purposes in a world of change and shifting circumstances. Functionalism employs both introspective and behavioristic methods of inquiry, and is strongly interested in genetic and abnormal studies.

Self-psychology is strongly influenced by idealistic ideas. It is also, in a sense, the least limited in scope of any of our schools. The leading tenet of self-psychology is the insistence upon the reality of a Self, known to introspection, which *has* mental states or experiences. Psychological experience cannot be interpreted, according to this school, without reference to the different attitudes which the self takes towards its world. This form of theory is not widely held in strictly psychological circles, but it is none the less highly respected.

The differences amongst these schools are such as may be expected to develop in a vigorous science. Although we are, in this country, presented with a considerable array of theories, general and special, these move, nevertheless, within certain well-recognized limits which makes them all akin. Psychology has attained an eminent place as an experimental science and all indications point toward its further substantial development and usefulness.

EXERCISES AND REFERENCES

CHAPTER I.—INTRODUCTION AND ORIENTATION

1. Define: Soul, spirit, mind, matter, consciousness, thought.

2. Why is psychology to be classed as a biological science?

3. Is mind a *thing?* Must it not be *some* thing?

4. In what kinds of behavior is mind exhibited?

5. What traits distinguish conscious behavior from reflex or habitual forms of behavior?

6. In what sense of the word is conscious behavior teleological? What is the opposite of teleological?

7. Name the most important branches of modern psychology.

8. How is general psychology to be distinguished from specialized branches of the subject?

9. Name ten of the most influential psychologists in this country at the present time.

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WARD: Psychological Principles.
PILLSBURY: Fundamentals of Psychology
JAMES: Principles of Psychology.
WILHELM WUNDT: Introduction to Psychology.

CHAPTER II.—THE EVOLUTION OF MIND

1. Why is the genetic method of study important in psychology?
2. What was James's criteria of intelligent behavior?
3. Describe amoeba. In what respects does its behavior appear to be psychical?
4. What is significant, from a psychological standpoint, in the behavior of Paramecium and Stentor?
5. Discuss specialization, differentiation, and organization in animals having sensori-motor nervous systems.
6. How does the behavior of "little-brained" creatures differ from that of the "big-brained"?
7. How are instinct and intelligence related? Upon what physiological traits and structures do they depend?
8. What do we mean by the "plasticity" of the nervous system? What is its importance?
9. Discuss trial and error learning.
10. In what respects may human thought be regarded as an extension and development of the trial and error method?

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JENNINGS: Behavior of Lower Organisms.
KIRKPATRICK: Genetic Psychology.
MCDOUGALL: Outlines of Psychology.
MITCHELL: Structure and Growth of the Mind.
WASHBURN: The Animal Mind.

CHAPTER III.—REACTIONS AND THE NERVOUS SYSTEM

1. Describe the movements of your face and head while you are at hard work and again while you are at recreation.
2. Illustrate by a drawing the course of the nervous impulse that is aroused by pricking your finger.
3. Make a drawing of the cerebrum in vertical section.
4. Make a drawing of the cerebrum showing the localization of cortical functions.
5. Make a drawing of a cross-section of the spinal cord showing the course of afferent and efferent impulses.

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Dunlap: Psychobiology.
Herrick: Introduction to Neurology. Second edition.
Howell: Text-book of Physiology. Eighth edition.
Lickey: The Nervous System.

CHAPTER IV.—HABIT

1. Define habit. Is all human conduct based on habit?
2. How do habits compare with inherited reflex forms of response to stimuli?
3. Discuss the several differential traits of habitual behavior.
4. What have the synapses to do with habit formation?
5. Explain, schematically, the process by which habits become established in the nervous system.
6. Discuss the process by which an habitual line of action, once initiated, is carried forward in the nervous system.
7. Is habit unvarying in action, like mechanical movement?
8. To what extent is man dependent on habit? Illustrate.
9. Compare instinctive and habitual forms of behavior.
10. Define "conditioned reflex." What new light does it throw on habit formation?

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Ladd and Woodworth: Elements of Physiological Psychology.
McDougall: Physiological Psychology.
Royce: Outlines of Psychology.
Stout: Analytic Psychology.
Woodworth: Psychology.

CHAPTER V.—SENSATION

1. Describe your visual experiences on going from a dark to a light room and reverse.
2. Produce visual after-images of several qualities. Describe the phenomena and the conditions.
3. Test yourself for peripheral color vision, using the primary colors. Describe the phenomena and the conditions.

4. Listen for difference tones and overtones on the piano and describe the experience.

5. Observe the taste of each of several articles of food or drink while you hold your nose tightly closed. Compare the tastes respectively in these conditions with the usual sensations.

6. Make a drawing of the eyeball in vertical section.

7. Show by a drawing the relations of the parts of the ear.

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BAIRD: "The Color Sensitivity of the Peripheral Retina," *Carnegie Institution of Washington*, Pub. No. 29, 1905.

BINGHAM: "Studies in Melody," *Psych. Rev. Mon.*, XII (1909), No. 50.

LADD and WOODWORTH: Elements of Physiological Psychology.

LE CONTE: Sight.

PETERSON: "Combination Tones and Other Related Auditory Phenomena," *Psych. Rev. Mon.*, IX (1908), No. 39.

RAND: "The Factors That Influence the Sensitivity of the Retina to Color," *Psych. Rev. Mon.*, XV (1913), No. 62.

WATT: The Psychology of Sound.

CHAPTER VI.—ATTENTION

1. What do we mean by "a selective process"?

2. How may we tell whether one is attending or not?

3. Define "clearness." How do we make things clear?

4. Discuss the different kinds or forms of attention.

5. How long can we attend to things?

6. How many objects can be attended to at once?

7. Discuss the objective and subjective factors which determine the direction of attention.

8. What is the *function of attention?* What does it do?

9. When do we attend to things? And why?

10. What is a "problematical element" in a situation? What is a "blur"?

11. How does attention clear up the "blurs" in a situation?

12. Discuss analysis and synthesis in attention.

13. How is attention related to mental development?

14. What is the cardinal error in most physiological explanations of attention?

15. Discuss the simple reaction experiment and its implications for the physiology of attention.

16. How does a temporary reflex differ from a true reflex or fixed habit?

17. How does the "physiological individual" function in the attentive process?

18. What is implied by calling attention "an equilibrium-maintaining process"?

19. Show that attention and consciousness are the same.

20. Define the term "Individual."

REFERENCES

ARNOLD: Attention and Interest.
BODE, B. H.: Chapter in *Creative Intelligence.*
DEWEY: Human Nature and Conduct.
PILLSBURY: Attention.
STOUT: Analytic Psychology, Book II.

CHAPTER VII.—PERCEPTION

1. Describe from experience an illusion and a hallucination.

2. Show from your own experience how perception, whether normal or illusory, is dependent upon ideas and emotional states.

3. Hold any solid object before the eyes. Describe its appearance to the right eye alone and to the left.

4. Why do we not have double images of persons in the rear when we are looking at one in front?

5. Explain the size of the moon on the horizon.

6. Explain as fully as possible why a newly acquired roughness upon a tooth seems large when it is touched by the tongue but later appears very small when it is similarly touched.

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LADD & WOODWORTH: Physiological Psychology, Part II, Chaps. 4, 5.
PIERCE: Studies in Auditory and Visual Space Perception.
PILLSBURY: Fundamentals of Psychology, Chaps. 8, 9.
SCRIPTURE: The New Psychology.

CHAPTER VIII.—MEMORY

1. Why are physical analogies misleading in the case of memory?
2. How does an organic conception of memory differ from a physical conception?
3. Outline the four topics discussed in this chapter.
4. Define memory proper.
5. What kinds of facts do we learn and remember most easily?
6. Discuss the experiments of Ebbinghaus and others in deliberate memorizing.
7. What is the span of memory?
8. How does Jost's law affect the distribution of repetitions in effective learning?
9. Why is it easier to remember poems or speeches as wholes than by parts?
10. Distinguish between ingenious and judicious mnemonic schemes.
11. What is the value of the laws of association?
12. How are habit and association related?
13. Show how attention affects association and learning by developing meanings.
14. Can one's natural retentiveness be improved?
15. In what ways *may* memory be improved?
16. Why must we forget in order to remember?
17. Describe and illustrate organic recall.
18. How does psychical recall differ from organic recall?
19. Explain how forgotten things may be recalled through their associations.
20. What is the significance of paramnesia?

REFERENCES

JAMES: Principles of Psychology, Ch. XVI.
MEUMANN: The Psychology of Learning.
STOUT: Analytic Psychology, Book II, Ch. IV.
WATT: Economy of Memory.

CHAPTER IX.—IMAGINATION

1. Define "Imagination" in its wider and narrower meanings.
2. What are images? What is their source?
3. In what respects do images differ from percepts?
4. Name and describe some experiences intermediate between percepts and pure images.
5. How does the brain function in the revival of images?
6. To what extent are the sense organs concerned in imaginal experiences?
7. Discuss Galton's methods and principal results.
8. Describe several different kinds of imagery. Illustrate.
9. Discuss Titchener's tentative classification of types of imagination.
10. What is meant by "Fancy"? Has it any function?
11. How are dreams usually explained? Does such explanation cover all cases of dreams?
12. Discuss healthy and unhealthy states of the imagination.
13. What part does imagination play in our practical dealings?
14. How does the scientific representation of the world differ from that of practical life?
15. How are images related to concepts?

REFERENCES

COLVIN and BAGLEY: Human Behavior, Ch. XIV.
JAMES: Principles of Psychology, Ch. XVIII.
PILLSBURY: Fundamentals of Psychology, Ch. XIV.
TITCHENER: A Textbook of Psychology, paragraphs 112-120.

CHAPTER X.—CONCEPTUAL THOUGHT

1. Define: Sensation, Perception, Conception.
2. How do concepts carry meanings? How are concepts related to words?
3. Discuss concrete and abstract concepts. Do they differ fundamentally?
4. What are the root errors of materialism and spiritualism?
5. How do psychology and logic differ in their treatment of concepts?

6. How are the meanings of objects embodied in them?
7. In what situations do meanings become objects of attention?
8. Show that a problematical situation always involves meanings.
9. Why do we refer to meaning as "the future in the present"?
10. What factors govern the development of meanings in an attentive situation?
11. Advance arguments and illustrations to support Titchener's views on meaning.
12. What do you understand by "thought at the associative level"? How does it function?
13. What is an abstraction? How does it originate?
14. Discuss the process by which we conceptualize our worlds.
15. Distinguish between reasoning and associative thinking. What is a middle term? How are concepts tools of analysis?

REFERENCES

CALKINS: Introduction to Psychology, Chs. XVII and XVIII.
CREIGHTON: An Introductory Logic, Ch. I.
JAMES: Principles of Psychology, Ch. XXII.
PILLSBURY: Reasoning.
RIGNANO: The Psychology of Reasoning.
STOUT: Manual of Psychology, Book II, Ch. VII.

CHAPTER XI.—FEELING AND EMOTION

1. Describe the motor reactions that accompany the major emotions. Can the emotions be identified by means of their accompanying reactions?
2. Cite from your own experience or from other sources illustrations of the fixation of emotional reactions.
3. Can the emotion or its expression be repressed or modified? What is there about an emotion that is altered by experience?
4. Is there any relation between our affective attitudes and our judgments? If so, account for it.
5. Suggest any possible applications of the psychology of feeling and emotion to the physician's problems; the lawyer's.
6. How does the state of pleasant feeling affect our thinking?

How do violently pleasant and unpleasant emotions affect thinking? Account for any differences that you have observed.

REFERENCES

ANGELL: "A Reconsideration of James's Theory of Emotion in the Light of Recent Criticisms," *Psych. Rev.*, XXIII (1916).
CANNON: Bodily Changes in Pain, Fear, Rage and Hunger.
DARWIN: The Expression of Emotions in Man and Animals.
JAMES: Principles of Psychology, Vol. II.
JASTROW: Temperament and Character.
RIBOT: The Psychology of the Emotions.

CHAPTER XII.—INSTINCT

1. Criticize: "The engineer instinctively closed the throttle."

2. What practical difference would it make if it were everywhere recognized as a fact that our social policies, crimes, benevolent acts, etc., are all the expressions of innate dispositions?

3. Why do you have the following tendencies: to investigate, to sympathize with the injured, to collect objects of any kind?

4. Account, if possible, for each of these forms of action without recourse to the theory of instinct: nest building; drawing back from the edge of a precipice; sneezing; hunting; inventing.

REFERENCES

CONRADI: Song and Call Notes of English Sparrows When Reared by Canaries, *Amer. Jour. Psych.*, XVI (1905), 190-198.
GAULT: Social Psychology, Chap. III.
MCDOUGALL: An Introduction to Social Psychology (4th edition).
SCOTT: Articles on Song Birds found in *Science*, XIV, XV, XIX.
THORNDIKE: The Original Nature of Man.
WATSON: Psychology from the Standpoint of a Behaviorist.
WOODWORTH: Psychology, A Study of Mental Life.

CHAPTER XIII.—VOLUNTARY CONDUCT

1. Define the volitional situation.
2. Give an analysis of the process of voluntary choice.
3. Discuss the five types of decision.
4. To what extent is decision "a conflict of impulses"?

5. How is character revealed in decision? What is here meant by character?

6. What do you understand by "determining tendencies"?

7. Discuss determining tendencies in relation to "effective conceptions."

8. How are bodily actions initiated? What part do kinaesthetic sensations play in this process?

9. Show how sensory stimuli function in the control of movements.

10. How are we to define "Will"?

11. What is meant by "a strong will"? Illustrate.

12. How may the will be trained and developed?

13. Discuss the weak-willed individual. How does the strong-willed person differ from one who is merely stubborn?

14. What is aboulia? How related to individuality?

REFERENCES

JAMES: Principles of Psychology, Ch. XXVI.
JASTROW: Fact and Fable in Psychology.
PUTNAM: Human Motives.
RIBOT: Diseases of the Will.

CHAPTER XIV.—APPLIED PSYCHOLOGY

1. State several possible definitions of intelligence.

2. Distinguish between intelligence and alertness.

3. Does it make any practical difference whether we think our tests get at intelligence or alertness? Explain.

4. Name the personal characteristics that seem to you to be most essential in each of five or six professions or trades.

5. Describe what you think may be a test to reveal each of the above characteristics.

6. Assume that the proportion of feeble-minded persons in the criminal population is but very little greater than that of the general population. What is the practical bearing of the assumption upon problems of criminal court procedure and of penology?

7. How does the differential psychology of races bear upon social psychology?

REFERENCES

GODDARD: The Kallikak Family.
HOLLINGWORTH: Vocational Psychology

JANET: Major Symptoms of Hysteria.
KITSON: The Mind of the Buyer.
KORNHAUSER and KINGSBURY: Psychological Tests in Business.
PINTNER and PATTERSON: A Scale of Performance Tests.
PRINCE: The Unconscious.
SCOTT: Increasing Human Efficiency in Business.
SEASHORE: The Psychology of Musical Talent.

CHAPTER XV.—A SKETCH OF THE HISTORY OF PSYCHOLOGY

1. Why is the study of the history of psychology important?

2. Discuss the traits of the ghost soul. What is a "soul" supposed to explain?

3. Discuss Thales and the early Greek philosophers.

4. Compare the views of Plato and Aristotle concerning the nature of the soul.

5. Why did Plato and Aristotle lay so much emphasis on reason and the life of reason?

6. Discuss the influence of St. Augustine and the mystics in developing the nature of inner consciousness.

7. Who was Democritus? How did he explain the soul?

8. State in outline the dualistic theory of Descartes. How did he suppose body and mind to be related?

9. Contrast materialism and spiritualism.

10. State carefully and distinguish between the parallelistic theories of Spinoza and Leibniz.

11. What new methods did Locke introduce into psychology?

12. Discuss associationism and its principal doctrines.

13. Name some of the men who contributed most to the development of philosophy in modern times.

14. What great work did Fechner accomplish?

15. Tell something about Wundt, his work and influence.

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BRETT: A History of Psychology.
DESSOIR: Outlines of the History of Psychology.
HALL: The Founders of Modern Psychology.
JANET and SEAILLES: History of the Problems of Psychology.
RAND: The Classical Psychologists.
ROBINSON and ROBINSON: Readings in General Psychology.

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